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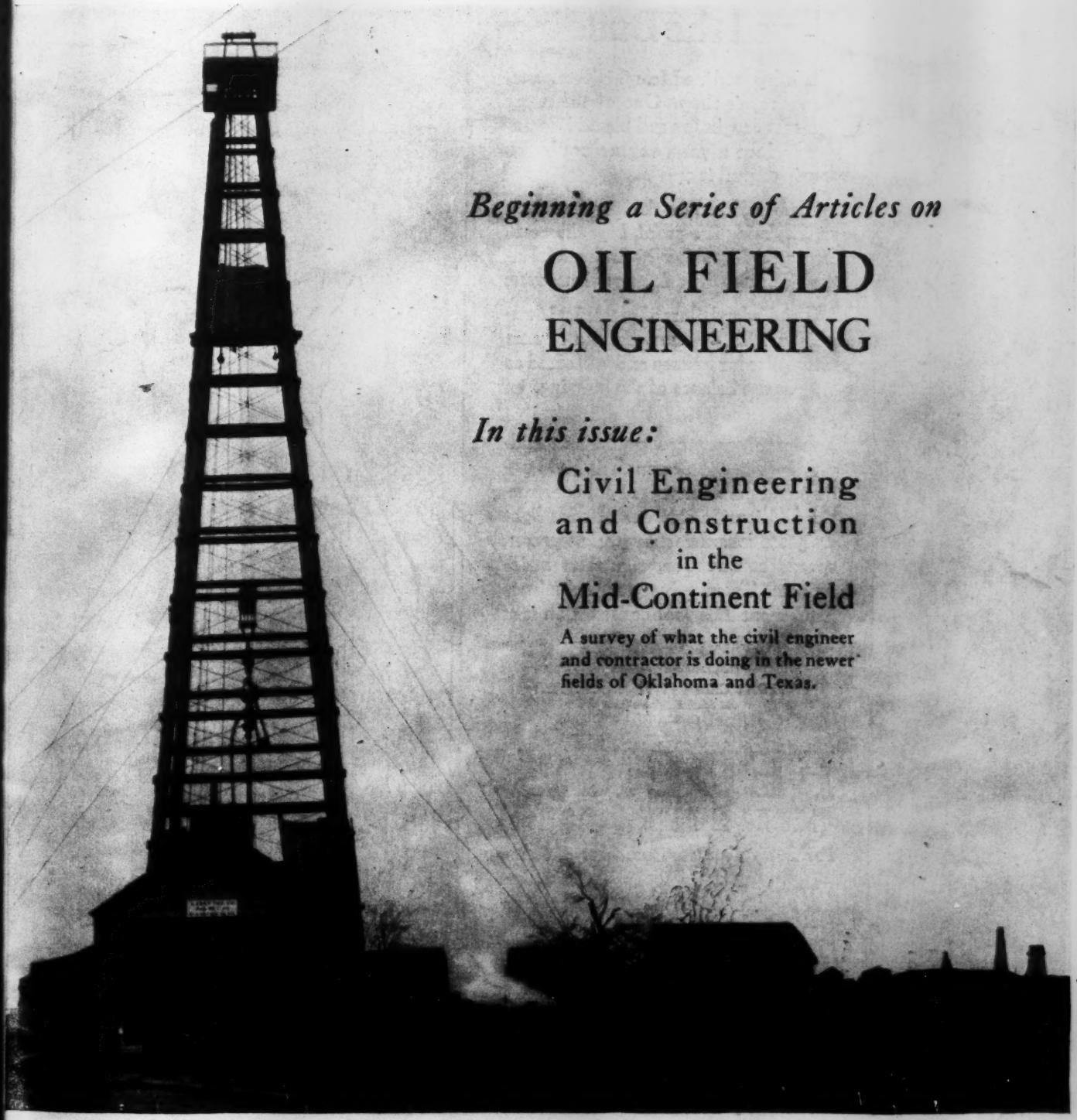
Engineering News-Record



Beginning a Series of Articles on

OIL FIELD ENGINEERING

In this issue:

Civil Engineering and Construction in the Mid-Continent Field

A survey of what the civil engineer and contractor is doing in the newer fields of Oklahoma and Texas.

The Box Car Burned But the Roof Saved the Building

IT happened in a Memphis, Tennessee, car repair shop. One of the many box cars caught fire and blazed like tinder before a yard engine could be found to pull it out.

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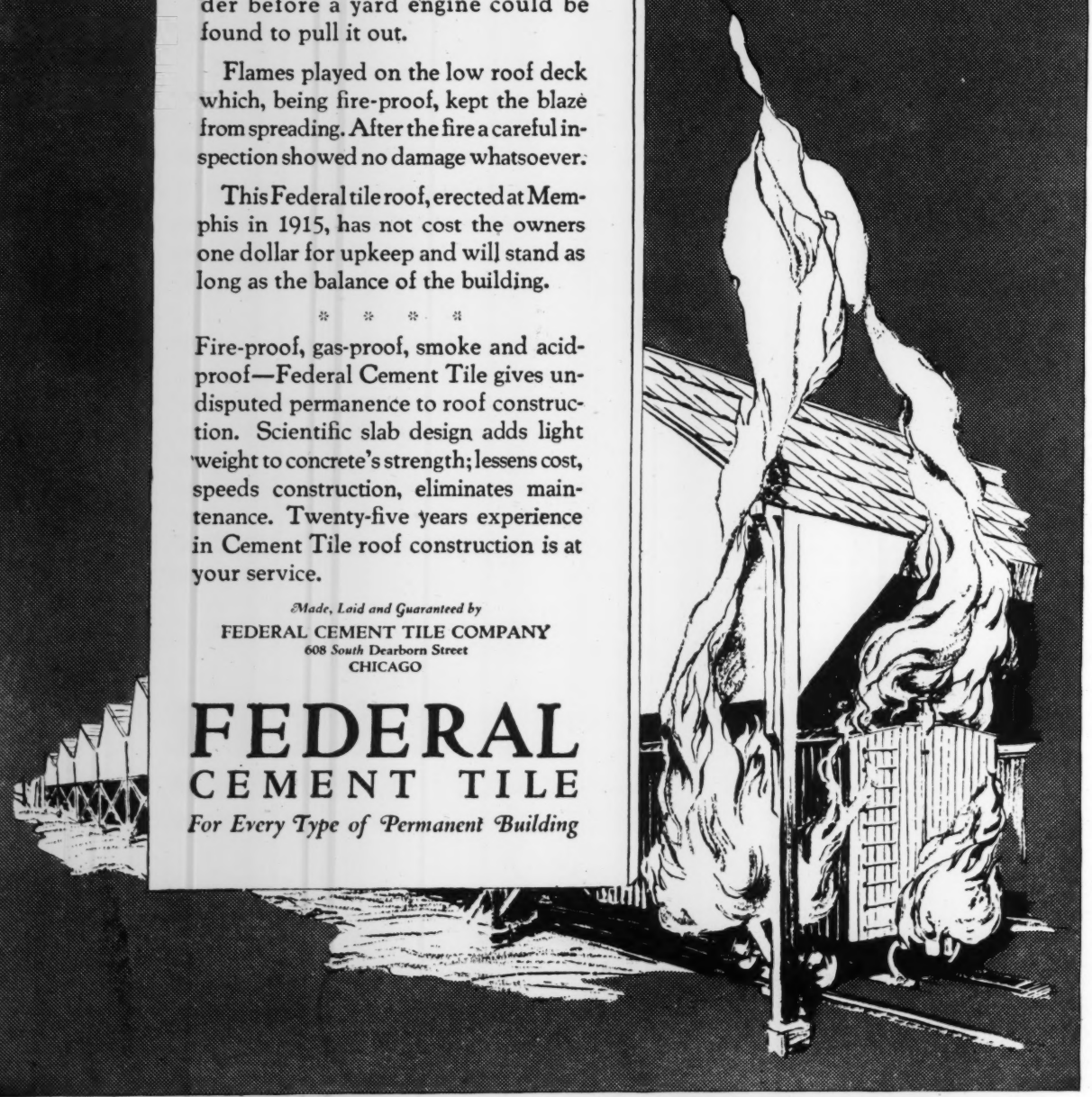


A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

FRANK C. WIGHT
Editor

Volume 98 NEW YORK, APRIL 14, 1927 Number 15

Industry at Geneva

SINCE the war there have been so many international conferences to consider the myriad problems that the war brought in its train that the average citizen has become somewhat callous in his appreciation of what they mean. There is danger, therefore, that the importance of the coming economic conference at Geneva may be lost. Probably nothing will come out of that meeting which will change immediately the course of the world, but it is important in its connotations and in its prospects of bringing about future economic development. For this is the first of the great international conferences that has been directed entirely toward commerce and industry. It is true that all international rivalry and national development are bound up in the business that men do, but hitherto where the nations have come together the real activity of man has been made subordinate to social, legal and financial relations. But at Geneva next month a picked lot of the industrialists of the world will meet to talk over production and consumption, industrial agreements, labor relations, the tariff and standardization. These men can decide nothing nor can they commit their countries to anything, but they can lay the foundations for a comity of thought which may well rise later in real international co-operation. So important has the meeting seemed to the publisher of this journal that it is sending to Geneva one of its vice-presidents, E. J. Mehren, formerly editor of *Engineering News-Record*, to attend the sessions and to report for the industrial leaders, the engineers and the business men who make up our readers the significant developments of the conference. Mr. Mehren's letters, as they appear in *Engineering News-Record*, should interpret this novel gathering to those especially concerned with the problems to be discussed in a manner better suited to their needs than the reports which will normally be sent out by the accredited newspaper representatives.

Multiple Roads

SUPERHIGHWAYS challenge one another for attention. This week a description is given of the magnificent Pico Boulevard out of Los Angeles. Two months ago a similarly splendid paved thoroughfare being built by Japanese engineers was described. Three weeks ago the prize-winning design for Chicago's superhighways was illustrated. We will not weary patience by further retrospection. All these roads are alike structurally and all are like the Cahuenga Pass road and the Detroit-Pontiac road completed last year. Indeed, one might reasonably assert from the evidence that pavement standards in superhighway construction had been invariably established. Except the Kobe-Osaka road in Japan, each of the broad highways named is in pavement design a series of narrow highways built side by side until enough 16 to 20-ft. units are laid down to make the new road. Practice varies in binding the parallel strips together with dowels, but each strip is of the popular thickened-edge cross-section established in the favor of highway engineers by the Bates road tests. With this condition, highway pavement construction becomes almost as flexible as railway track construction when it is desired or it becomes necessary to multiply vehicle ways. This is excellent. The question comes up, however, whether a conception of a superhighway as merely a multiple of ordinary highways is all that we should expect of a proper visioning of this device of modern transportation.

Teaching Teachers

SCHOOLS for teachers are not new, but those for engineering teachers have been confined to the individual colleges and even these have not been much more than faculty conferences. The innovation proposed by the Society for the Promotion of Engineering Education, as noted in the news pages of this issue, is a decidedly worth while experiment. To gather together in the delightful summer surroundings of either Ithaca or Madison a group of engineering teachers and there systematically to instruct them in pedagogical fundamentals as they apply to engineering should be most useful. One suggestion to those conducting the school is offered. The ordinary engineer or editor makes no claim to be an expert in pedagogy, so he should hesitate to plan or criticize any details of a course in instruction at such a school. But this same average individual does know from observation that the average engineering instructor, when instructing, is a dull and prosy individual so immersed in the minutiæ of his specialty as to forget its relation to engineering or even to understand what a human thing engineering really is. Can not the faculty of this engineering teachers school take this opportunity to get across to the engineering teachers the importance of tying in their specialties to the engineering whole and of interesting the student in the broad philosophy and practice of engineering as well as instructing him in its mechanisms? The troubles with our engineering curricula lie more with men than content. Here is one chance to plant a few seeds of reform.

Economy and Publicity

DETROIT'S city council is on an economy splurge and some of the city engineers are the principal victims. The mayor seems to be somewhat better advised as to the necessity of engineering services in a municipality than is the council, for he recently authorized the retention of a number of the engineering employees and additional salaries for some others, but the council, in the words of one of its members, feels that "the administration is being overridden with engineerites." "We are," he says, "responsible to the people for the expenditure of public funds and we resolved to

eliminate all unnecessary items." These "unnecessary" items include the mayor's investigating engineer and research engineer and the traffic engineer, as well as the recommended $5,000 addition to the $10,000 salary of the superintendent of the water department. Evidently, there is need for some publicity work in Detroit. No one can complain about a properly devised economy program, but when a city councilman, laboring under the usual mental equipment of such officials, makes the broad statement that engineering is an unnecessary item in city expenditure, it would certainly appear to be up to the engineers of the city to inform the citizens just wherein economy lies in the employment of engineers. And also they might try to find out just what is the distinction between an engineer and an engineerite.

Difficult to Predict

HOW difficult it is to predict the future is well illustrated by a casual trip around the city of Washington. It is now nearly twenty-five years since ground was first broken for the Union Station there. That station is situated in what was a sump in the topography and a part of the new plan consisted in raising the ground floor, and the entrance plaza, to a level some thirty or forty feet higher than the natural ground, a rearrangement which required changed grades on most of the approach streets. All of these streets were lined with small residences, which the grade revision left at varying depths below the streets and sidewalks. That was all a quarter-century ago, but anyone today approaching the Union Station from the west will pass by these same little block houses, with their second stories at sidewalk level and with descending steps into the front door. How many of those who planned that station in 1904 would have said then that in 1927 these old houses would still have been disfiguring the streets of our capital city. Acre after acre of outlying woods and fields to the north and west of Washington have in this time been converted into urban and suburban districts, the city has grown from a quarter to a half million, but the approaches to the Union Station remain, squalid and uninviting, evidence of the uncertainty in city growth.

Interest in Toll Bridges

AT ITS last session the Legislature of the State of Washington passed an act opposing further private toll-bridge construction in the state. Movements having a similar objective have been under way in one or two Mid-Western states for some months, but apparently have not reached the stage of active legislation. Now comes Governor Smith of New York with a veto of a private toll-bridge bill which was to provide for the construction of a highway crossing over the St. Lawrence in the Thousand Islands region. He bases his veto on the general ground that if toll bridges are to be built, the state should build them. He also remarks on how profitable the Bear Mountain bridge has been to the stockholders of this private toll enterprise, and he then proceeds to recommend a plan of the "Authority" type for the construction of toll bridges under semi-public auspices. In spite of the fact that the governor has taken this occasion to ride again his "Authority" hobby, and that he is manifestly unfair to the initiative that conceived and projected the Bear Mountain bridge, there can be no doubt of the significance of this message as further evidence of the growth of sentiment against private toll bridges. It was precisely this development against which we endeavored to give a warning in the editorial, "Toll Bridge Reform," in our issue of Dec. 2 last. Private toll-bridge enterprise has produced some very valuable results. It is able to provide a needed traffic improvement more quickly, on a more efficient plan, and with greater economy than public construction. These are meritorious features which argue strongly for the continuance of the system. The present prospect, however, is that the system will not long survive, or at least that its scope will be greatly curtailed, through public opposition to the purely exploitational development of private toll bridges. It is readily possible to combine proper returns for the private risk and enterprise with due regard for the public interest and with proper recognition of the almost universal sentiment in favor of a road transportation system that shall in time be wholly free. The veto of the St. Lawrence bridge bill is a renewed suggestion that private toll-bridge enterprise should reshape its plans accordingly.

How Not to Build Bridges

THAT the Authority plan which is suggested for the construction of a St. Lawrence River bridge has fatal weaknesses was pointed out on several occasions in these columns recently, with reference to both power development and bridge construction. The complications recently added to the task of the Port of New York Authority, a body of this type, in its assigned work of building a bridge across the Hudson River from New York to Fort Lee were pointed out in a note in this column only two weeks ago (March 31, p. 512). Within the past ten days these complications have been made further involved. The act of the New Jersey Legislature in attempting to superimpose control by a political board upon the bi-state Port Authority was quickly seen to be illegal, and the legislature repealed its action and substituted therefor a law giving to the governor of the state full veto power over any contract of the Port Authority. The grant of such veto power to the governor, it happens, was specifically provided for in the compact between the two states under which the Port Authority was established, but it, and the similar New York bill passed as a reprisal or defensive measure, open mischievous possibilities of political control of the bridge construction job quite as serious as if the veto power were reposed in a board instead of the governor. The present situation, then, is that the Port Authority can take no final action, but is subordinate to the governors of New York and New Jersey—men who, whatever their other merits may be, unfortunately lack all knowledge of bridges or of the problems involved in building the greatest structure in the world. It is hardly necessary to point out that this is not a successful or even feasible way to build bridges. New Jersey's action has abruptly destroyed the promising outlook for early and successful construction of the Fort Lee bridge, and leaves the purchasers of its bonds issued for its construction in a dubious position. It constitutes as striking an indictment of business ability of government as we can recall at the moment. At the same time, it presents a serious challenge to those who support the principle of public instead of private toll-bridge construction.

Value for Rate-Making Purposes

WHAT is value for rate-making purposes? Does it differ from value in the ordinary sense of the word? The Interstate Commerce Commission thinks that it does; that the value of a railroad for such purposes "approaches more nearly the reasonable and necessary investment in the property than the cost of reproducing it at a particular time."

In thus stating its views in determining the value of the St. Louis & O'Fallon Ry. for the purpose of recapture of excess earnings, the commission takes a view different from that quite generally believed to be the view of the Supreme Court. For this reason, as well as for the fact that the commission's statement is a clear exposition of the views of those who hold to the original cost theory of utility valuation for rates as opposed to spot reproduction, its opinion, as abstracted on p. 612 of this issue, is worthy of study. In the O'Fallon case, the commission found a rate-making value for the successive recapture periods, as for example, 1923, based upon 1923 market value for lands; cost of other property installed since June 30, 1919; using unit prices of 1914 enhanced by allowance for increased cost of units installed between 1914 and 1919; and for units installed prior to June 30, 1914, unit prices of 1914, with allowances for depreciation in each period. The 1914 unit prices were based upon prices for the five-year period ending June 30, 1914.

The O'Fallon case in itself is unimportant. It is but a minor one of the hundreds to be decided by the commission in fulfilling the requirements of the Interstate Commerce Act. But as the first case in which the commission attempts to collect what the act terms "excess income," it assumes unusual importance, for it requires the commission to make a full exposition of its methods of setting a value for rate-making purposes upon the O'Fallon Ry. in order that the Supreme Court may say, when the case is brought before it, whether the commission's methods are correct or not.

What the majority of the commission says in support of its view that a value for rate-making purposes differs from other values of a railroad property, such, for instance, as the market value, is not only a convincing argument but also one which should make the railroad directors stop to ponder whether they are not on the wrong track when they follow in the lead of the spot reproductionist just because spot reproduction sets a much higher value upon their properties at the present time. If there is only *one* value for any railroad, then its directors may have good reason to cling to the spot reproduction theory—particularly the directors of the smaller companies which may be absorbed in railroad consolidations—because it is reasonable to suppose that once such a value were fixed, it would serve as the commission's chief guide in determining the compensation to the stockholders in a consolidation with a larger system. But as the commission holds that a value for rate-making purposes is distinct from other values, there are many reasons why the cost-of-reproduction-new method of computing a value upon which rates are to be based should not be used in regulating the railroads.

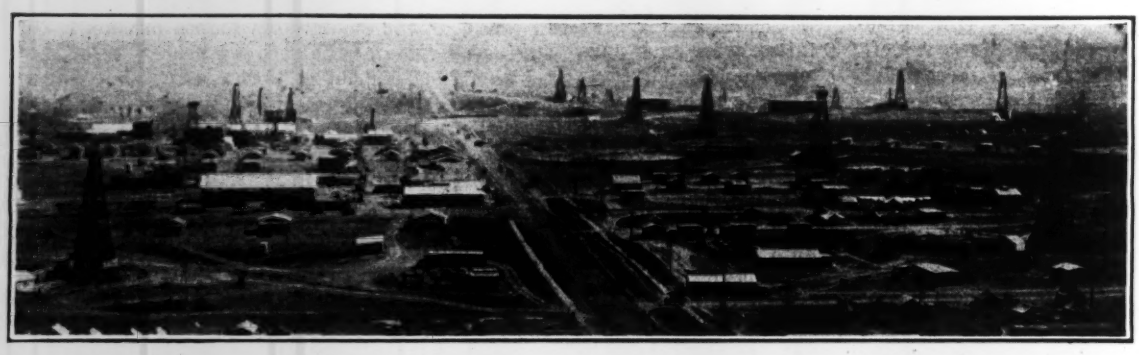
First, and more important, is the fact that the investment theory of determining the value upon which rates are based—as followed by the commission except in the case of the value of lands—results in a stable value, whereas the spot-reproduction theory results in a value which fluctuates from year to year, falling rapidly in times of depression and wiping out large amounts of capital just when financial stability is most needed. For instance, as the commission points out, by taking the aggregate value of the railroad properties of the country as $18,000,000,000 in 1914 and applying the bureau's ratios for changes in cost from year to year, it is found that the value of the same properties becomes 41.4 billions in 1920, 35.1 billions in 1921, 28.3 billions in 1922, and 31.3 billions in 1923. On that basis, the value of the railroad properties more than doubled between 1914 and 1920, then declined 6.3 *billions* in 1921, made a further loss of 6.8 billions in 1922, and then gained only 3 billions in 1923.

It should not be forgotten, either, that the value of the railroad properties of the country as estimated by the commission's method is not far from their book value. Present rates are such that many of the companies can pay fair dividends upon their stock. If values are to be inflated far beyond the book values and rates are increased to pay a fair return on such higher values, the increase in net income will accrue to the payment of dividends—the present returns being more than sufficient to pay the bond interest—with the result that dividends on most railroads would be beyond all reason. The effect of such a situation is obvious. The outcry against the higher rate, fat dividends and watered stock would be followed by an orgy of anti-railroad legislation likely to place the railroads in far less favorable circumstances than they find themselves at the present time.

The whole question of valuation is notoriously complicated. The Supreme Court, the last word on the subject in this country, has consistently refused to lay down any but the most general rules which admit of all sorts of interpretations when applied to specific cases. Nevertheless there is a tendency for those arguing any valuation case to attempt to twist those generalities to their own advantage. It must be remembered that the Interstate Commerce Commission is concerned here with but one kind of valuation, that which governs the regulation of rates, and more especially the control of excess income, on one kind of public utility for which the Congress has laid down a special form of treatment. It was the obvious intent of Congress to provide some way of preventing the railways of the country from making an undue profit out of those whom they serve. That limitation can be imposed first by fixing a value and second by limiting the return on that value. The majority views of the commission state a logical method of fixing value. The commission still has the authority to control the situation through the limitation of return, and the Supreme Court still has to decide whether the manifest intention of Congress does not put railway valuation in a class by itself.

The commission's statement is applicable to a special use of valuation and is not necessarily a precedent for other uses. The question will ultimately be decided by the Supreme Court, but it is a fair question whether the railroads would not be better off under the commission's interpretation than under the spot-reproduction theory that all the public utility interests are so enthusiastically assuming to be the dominating theory of the Supreme Court.

One of a Series of Articles on
OIL FIELD ENGINEERING



Civil Engineering and Construction in the Mid-Continent Oil Fields

By Waldo G. Bowman
Assistant Editor, *Engineering News-Record*

I—Organization and Scope

SOME OIL field is always in the public prints. And it is usually first-page news. As fast as one boom field settles down to normality another spectacular wildcat well is discovered and the whole fervid cycle of development is repeated. Arkansas, California, Texas, Kansas and Oklahoma take their turn in providing the setting, and each new field affords a bonanza for those adventurous spirits who must always be on the firing line. Those of us who are just as daring, but prefer our adventure in an arm-chair at home, are the willing victims of stories of fabulous wealth, of pioneer difficulties, of cities appearing almost over night where before only a sleepy town or even a barren cattle country existed, of hi-jacking, of gunmen and the other trappings and frills of a Wild West drama. One hesitates to raise a voice against the credibility of these tales. Indeed, there is enough essence of truth in most of them that a flat denial that they do not exist is impossible. However, in order not to defeat the purpose of this article, which is to point out the scope of engineering work, more particularly the civil engineering work, in the oil fields, it is necessary to explode some of these fantasies, even to disregard some of the facts of a more romantic nature, so that the real basis of the advancement of this phenomenal industry may be looked at in a sane light.

FIG. 1—NEW OIL PRODUCING AREAS IN OKLAHOMA AND TEXAS

A member of parliament in replying to a particularly scathing presentation of a case once said, "My honorable opponent has spoken many things which are new and many things which are true. Unfortunately, the things that are new are not true, and the things that are true are not new." Something similar might be said about the oil fields. Millions in profits are made, but not usually by individuals. Huge and rich corporations spend millions to make millions. Pioneer difficulties are encountered and conquered. But on what other large engineering work is this not the case? Cities spring up over night, but the populations are of a nomadic and itinerant nature, and the city finds itself after the boom to be at best a well-to-do small town. Tulsa is an exception and Amarillo has dreams and possibilities but neither is an oil town in the usual sense. The so-called Wild West activities are around any construction job. Stripped of the cloak of fiction and romance, the engineering possibilities of oil field development loom large.

Apparently a principle of successful geology is to prospect for oil pools only in desolate and out-of-the-way places. At any rate, most of them have been and are so situated. The present booming Seminole County field in Oklahoma is reached only by a branch line railroad. The phenomenal producing area in the Texas Panhandle, east and north of Amarillo, was most barren prairie and mesa country less than a year ago. This very inaccessibility, however, provides an ideal setting for the exercising of many fundamental phases of civil engineering and construction. Surveys must be made, transportation must be developed, and construction forces must be assembled and put to work building derricks, compressor plants, pump stations, pipe lines, and camp accommodations including housing, sewage disposal plants and water-supply systems. The procedure necessary to carry out this program differs in many respects from that usually found in the broader field of civil engineering and construction.

Speed in reaching the point where oil can be produced is the major force. Cost, broadly speaking, is no consideration. Brute strength and practical expedients, coupled with as much construction common sense as the pressure will allow, are the guide lines, between which engineering principles would seem to have a hard time functioning. They do, if the usual definition for engineering principles is given—the rules which if followed will give the best possible structure at the lowest possible cost. But engineering principles in the oil fields, meaning for the present the spectacular boom fields, are those rules which will give the best possible structure in the least possible time. Too much economy is false economy. It is largely this fact that makes oil field engineering different from all other engineering, that makes its problems special problems, and that makes a study of the civil engineering ramifications of the oil industry of special significance.

Organization and Personnel

What sort of an organization is necessary to carry out this oil field work? In what ways, if any, do its directing forces differ from those in the more general field of engineering and construction? Certainly the business of oil production consists in directing the forces of nature to the economic use of man; that has been laid down often as a blanket definition of civil engineering. It is, then, rather surprising that the civil engineer *per se* is hard to recognize in the oil fields. But so is the mechanical engineer. And the mining engineer. In their place has grown another breed. Perhaps the basic experience of this new engineer has been in one of the older branches but now all of his problems are secondary to the major one of producing oil. It must be secured by any or all technical means and one man must use them all, for the industry—at least in its present stage of development—does not lend itself to specialist engineering along the lines of the accepted branches. The result has been a new kind of engineer. Some choose to call him a petroleum engineer. To date he has developed in the oil business mostly in the employ of the large companies. The University of Oklahoma, the University of Michigan, and the University of California have outstanding courses in petroleum engineering. Other schools, mostly in the oil states, are meeting the need in the same way. They recognize that petroleum engineering deals with the producing, the distribution and the refining of oil and that it uses only those principles of civil, mechanical, electrical, mining and chemical engineering that are applicable to the development of the oil industry.

Because most present-day oil company officials have grown up with the industry and have seen it reach an enviable position largely without the use of engineers they are slow to recognize that a technical approach to many of their problems will carry them even further. Engineers have been felt to be more of a luxury than a necessity. But the engineer's day is coming. Many think it is at hand. Much is augured by present tendencies in the American Petroleum Institute. Beginning as a social organization, the A.P.I. soon developed into a sort of trade association. Within the past two or three years it has appointed standardization committees made up of engineers of the various companies, each committee to deal with a specific material or piece of equipment. The constructive work of these committees is commanding more and more of the attention of the executives. One company which has hired no one but graduate engineers for the past five years has had a phenomenal growth. A former chief engineer, recently made vice-president in charge of production of one of the large companies, remarked that from now on no one but graduate engineers would be considered for open positions. It is interesting to note that of eight chief engineers of large oil companies operating in the mid-continent field, five were trained as civil engineers, two as mechanical, and one as an electrical.

The accompanying organization charts are indicative of the manner in which work is delegated by two of the large producing companies. The pipe-line companies

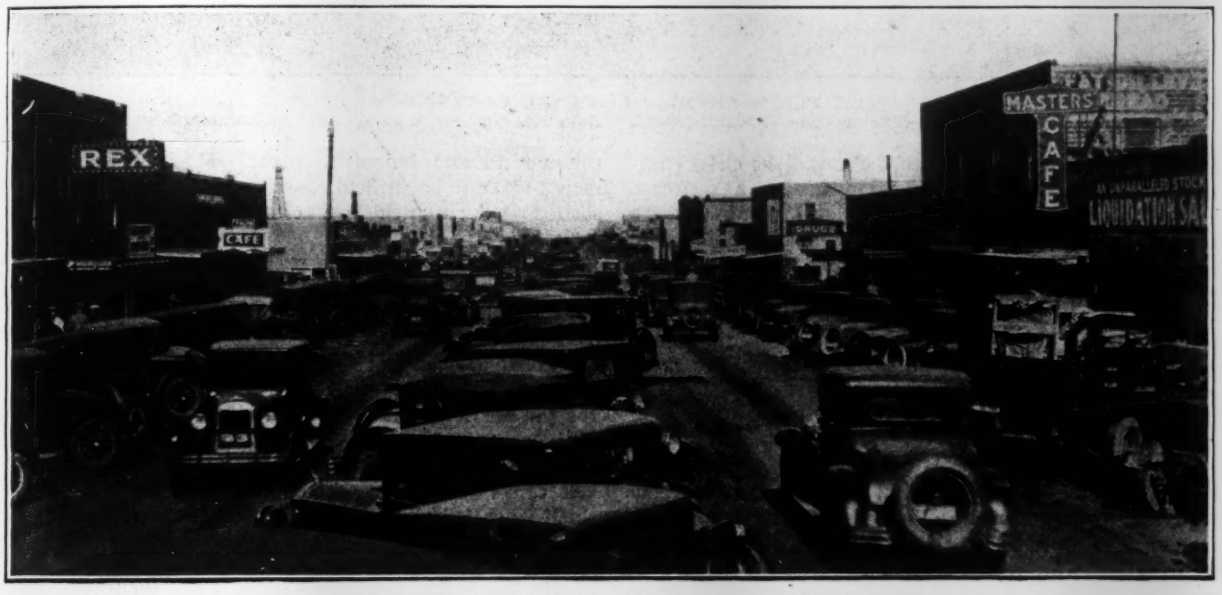


FIG. 2—THIRTEEN MONTHS OLD AND 30,000 POPULATION

Borger, Texas, built in the spring of 1926, 30 miles from a railroad, in the Texas Panhandle oil field is now on a railroad and has several blocks of brick buildings. The main street shown is 4 miles long.

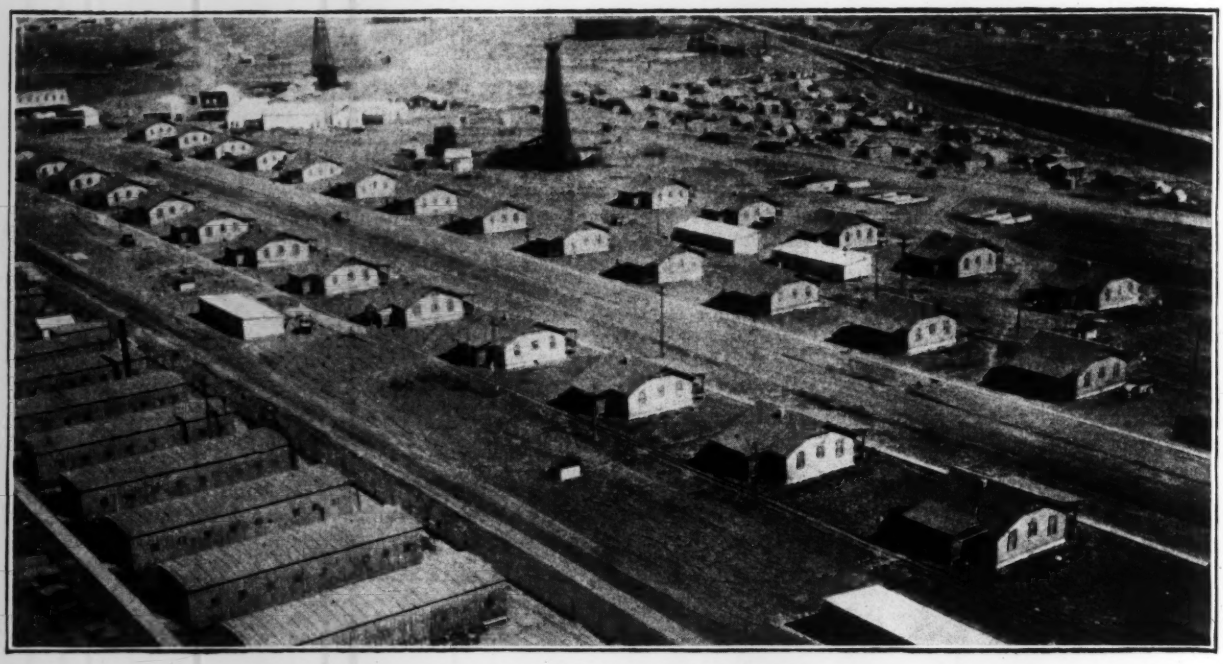


FIG. 3—AN OIL FIELD CAMP IN TEXAS
Four-room houses for families with bunk houses in foreground. Note wide streets and garages and incinerators behind houses.

are organized much as are railroads, and the chief engineer's duties are much the same as for a railroad. Consulting engineers on civil engineering subjects are few in the oil fields, although there are several devoting their time to production work, notably the much talked of air-gas lift method. A number also do surveying and mapping work for smaller operators. Much work is contracted by all the oil companies, and grading, tank erection, drilling, and pipe-line construction are more often than not contracting operations.

Scope of Civil Engineering

The intent of this article and the one to follow is to separate the problems of civil engineering and construction from the composite body of petroleum engineering. It will consider only production and distribution—the operations that occur in the field. The civil engineering problems of a refinery are, after all, those common to any industrial plant. Most of the statements refer to boom field construction since normal and settled producing fields are not so prolific of construction activity.

Ask any of the old-time production executives of an oil company what work of a civil engineering nature is done, and he will probably answer, "Well, we do a great deal of surveying and map making and check manufacturers' derrick and tank designs from time to time." Suggest that there are probably concrete foundations for the derricks, that there are pump stations to build, that there are water-supply and sewerage systems necessary in connection with camps, that there are derricks and tanks to erect, that there are settling basins or slush pits to build for the rotary drilling operations, that there are pipe lines to design and construct, and that there must be large grading operations around camps and tank farms, and he will say, "Oh, yes, but

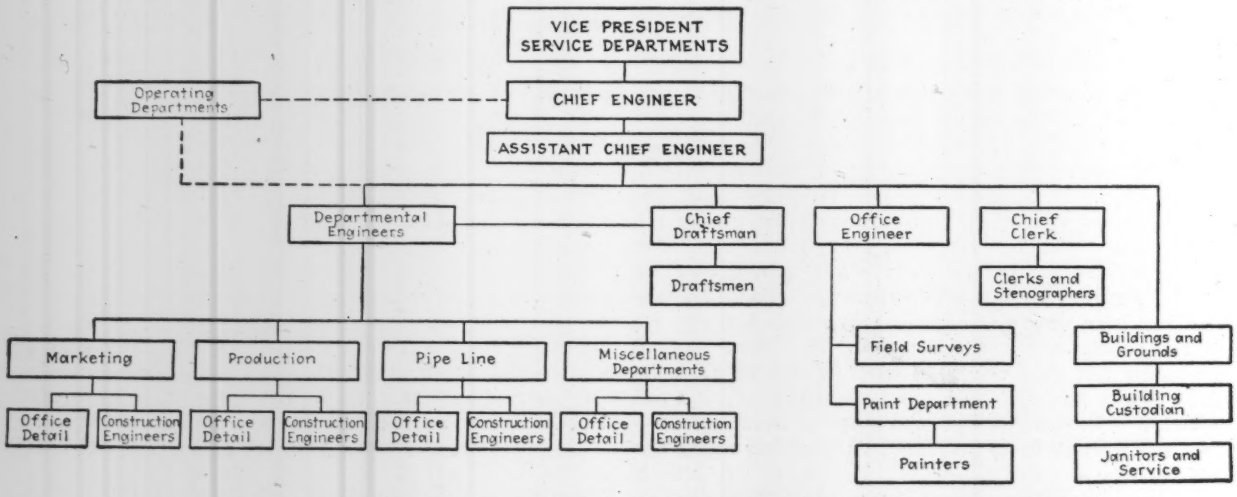


FIG. 4—ORGANIZATION, GENERAL ENGINEERING DEPARTMENT, MARLAND REFINING CO.

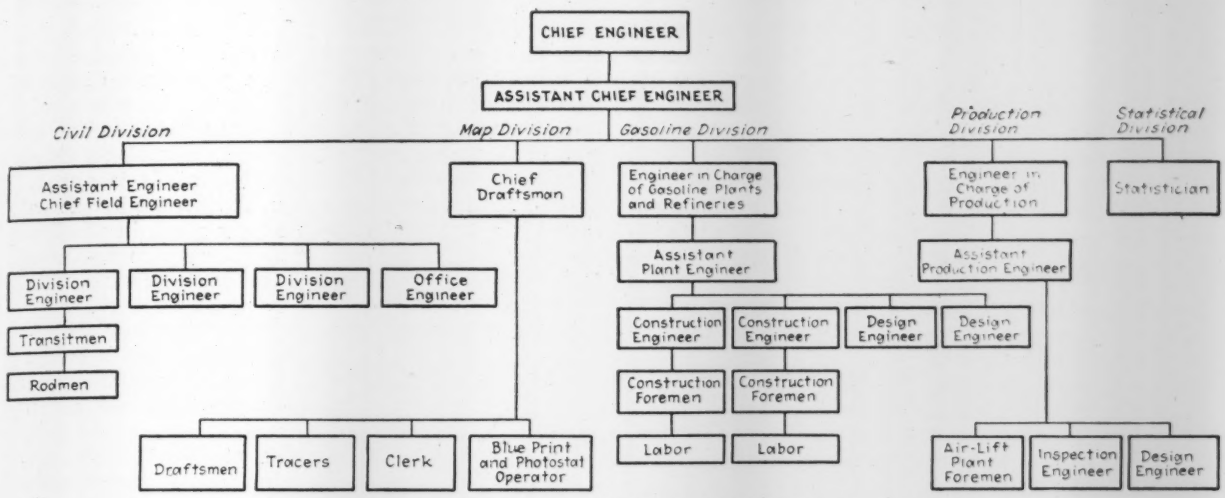


FIG. 5—ENGINEERING ORGANIZATION, CARTER OIL CO.

The engineer in charge of production has charge of air-gas lift, production machinery and equipment, efficiency, and new production methods. Each division engineer has charge of survey locations of wells, pipe lines, tank farms, camps, etc.

there is not much civil engineering about them. Our construction forces do most of this work, varying the procedure and structures as conditions in the field require."

From this attitude it is deduced that either the civil engineer has become a constructor, or the constructor has become a civil engineer. Talks with the chief engineers of many of the large oil companies and several weeks spent in the Seminole field in Oklahoma and the Texas Panhandle fields indicate that both deductions are true.

It is in the chief engineer's office that all designs, plans and orders originate. One of the chief problems is to standardize plans to as great an extent as possible so that the man in the field has a minimum of planning and designing work to do. The civil engineering work is large in volume but most of it is elementary. Now and then a major job occurs such as the construction of a large natural gasoline plant or the design and building of a long pipe line, but these are exceptions. The one common characteristic of all the work is that it is rapidly erected under rush conditions.

To one used to viewing general construction and civil engineering work, it seems that the oil field construction work is being well handled with the exception of road building and maintenance. At the risk of being reminded that such work is not a part of the curriculum of the oil company's activities, it is necessary to criticize the road conditions in the Seminole field. Quite passable roads exist in the Panhandle field, but were built because no others had existed previously and transportation was impossible without them. They were built by and at the expense of one company whose holdings are extensive. They are an exception.

In the Seminole field roads had existed prior to the discovery of oil. They still exist, but are practically impassable. Stories of mules drowning in mud holes and of ten teams and a heavy tractor being required to haul an ordinary boiler through the streets of Seminole are not exaggerated. Such conditions can be

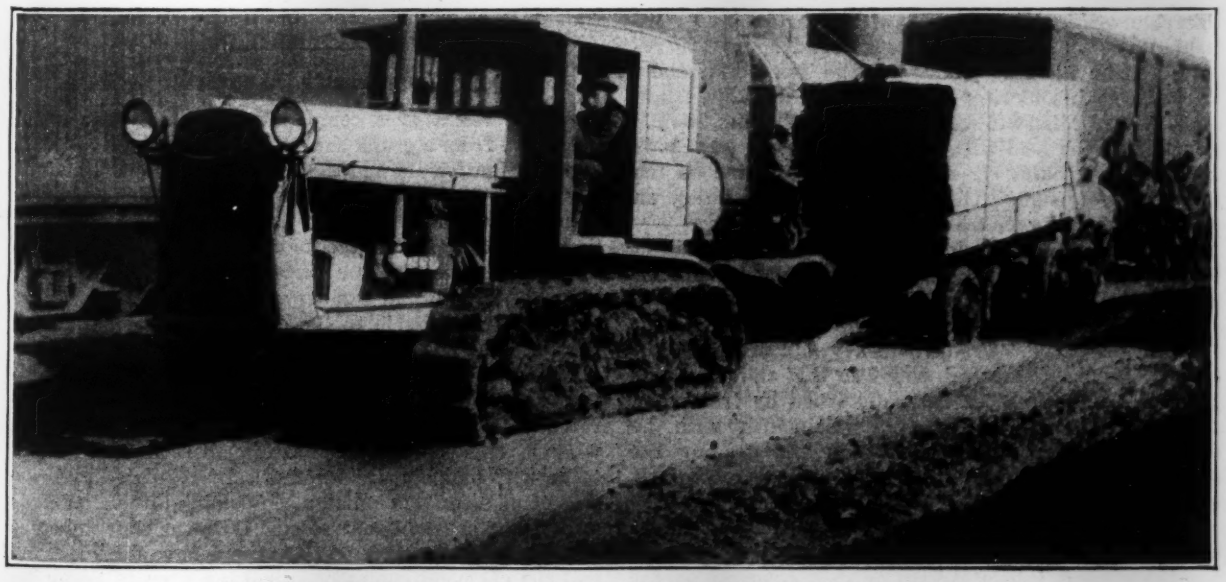


FIG. 6—MODERN TRANSPORTATION COMBATS EXTREME ROAD CONDITIONS

charged to two causes—lack of co-operation among the oil companies, and lack of funds by the state highway department. No plan and no money tells the story.

What is the cure? The oil companies have the money and the state has the construction forces and stands ready to use them. Oil companies operating in a field could contribute on some equitable basis to a general road fund which could be administered by the state highway department. When each well drilled costs between $50,000 and $100,000, a few thousand dollars spent on improving transportation facilities seems like a good investment. Probably no road that could be built would stand up perfectly under oil field hauling, but in Seminole a few ditches alongside the present roads would be a big improvement. Losing sight of engineering economies because of the paramount task of getting oil and getting it quickly is nowhere better illustrated than in the condition of the roads in a boom oil field.

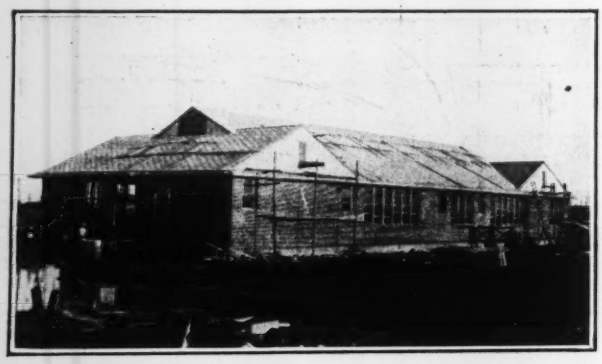


FIG. 7—SCHOOL BUILDING AT OIL FIELD CAMP IN TEXAS PANHANDLE

Two quite different classes of engineering activity are represented by the production operations and by the distribution or pipe-line operations. They will be considered separately. Surveying and mapping of producing areas are major problems. Well locations are fixed a certain distance from property lines, and a certain distance apart. The result is that wells are spaced from 500 to 700 ft. apart (depending on the agreement in the field) in both directions, and must be so located by the survey party. Considerable knowledge of old land survey methods is necessary to locate section and property corners and bench marks. Levels, taken at each well location, are the basis for all underground mapping, the depth and thickness of the various strata being recorded as drilling progresses.

Provision of transportation facilities entails considerable work. The highway situation has been commented upon. Railroad extensions and spurs are required. The oil field activities in the Texas Panhandle have placed this territory first in railroad construction work in the United States. The Santa Fé built a 30-mile branch into the field with 32 miles of side track. It is now double-tracking 72 miles of its main line on the Panhandle division. The Rock Island is building an outlet north to its main line at Liberal, Kansas.

One of the first requisites in any field are housing facilities for the men. Oil company camps are complete in every detail. Here, indeed, engineering knowledge has functioned admirably. The streets are laid out exceptionally wide. Traffic is heavy and fire possibilities are large. Camps are zoned so that the occupants of residences will be as little disturbed by traffic and production operations as possible. Coincident with the first operations, those of surveying and grading the site, the sewer system is laid out and constructed. It consists of vitrified tile mains and laterals with cemented joints. The sewers discharge into one or more septic tanks of conventional design, these usually turning the effluent into a stream or to a sump in porous ground.

The water systems used get their supply either from streams or from wells. In either case an elevated tank is usually necessary to provide pressure. Complete plants of settling and coagulation basins, commercial water softeners, and chlorine dosing facilities are the rule in the Seminole field. One of these plants treats 22,000 bbl. per day of stream water. It is situated about 12 miles from the camp. A separate article will consider a 200,000-bbl. well supply plant in the Panhandle. Here, too, elevated tank pressure was used, but only for fire protection, direct pump pressure being used on all the mains.

Types of houses differ. In most cases they are of a knockdown variety but put up in a substantial manner. Individual 3-, 4-, and 5-room houses are provided for men with families. Bunkhouses are provided for the day labor gang. Substantial floors, in some cases hardwood, hot and cold running water, gas heat, or in some cases steam make the camps outstanding as models for construction work.

The aggregate yardage of concrete used in an oil field is large. Derrick foundations more often than not are of concrete. Mud sills were formerly the rule. Standard designs are prepared in the office for the piers and equipment bases, but these may be varied to suit soil conditions. Pyramidal sloping piers are seldom used, a stepped design requiring much simpler formwork. The yardage in each location usually is not sufficient to warrant much of a concreting plan. A 5-S or 7-S building mixer is usual. Building foundations are handled in the same manner. Schoolhouses and hospitals are constructed for the company's forces and usually follow modern design.

A second article, to follow in an early issue, will discuss the details of drillings, pipe lines and other structures.—EDITOR.

Byproduct from Waste that Damaged Sewer

As the result of a complaint made last year about bad odors from a trunk sewer in Orange County, Calif., an investigation showed the presence of unusual quantities of H_2S gas that had resulted in rapid disintegration of mortar in brick manholes and in the joints between the vitrified segmental blocks with which the sewer was lined. Analysis of the sewage was made by the State Board of Health and a survey of the district traced the source of the trouble to the discharge of a by-product from a plant which converts molasses into alcohol. Experiments made with the co-operation of the manufacturer showed that the waste material could be evaporated to a solid. An arrangement was worked out whereby this could be done at low operating cost in retorts, with temperature automatically regulated giving a sort of pumice from which a compound quite valuable as a fertilizer is readily extracted. Both the odor nuisance and the disintegration of the sewers have been stopped and the chemical company is making a profit from the new by-product.

Los Angeles Builds Superhighway to Ocean Beach

A Lighted Highway 6½ Miles Long Paved 70 Ft. Wide Constructed Last Year at Cost of a Million Dollars

By John C. Shaw
City Engineer, Los Angeles, Calif.

A MAJOR superhighway operation in 1926 was the construction of an enlarged Pico Boulevard to connect the metropolitan area of Los Angeles with Santa Monica and the west-coast beach area. The new thoroughfare, 6.74 miles long, is paved 70 ft. wide and called into service about every phase of municipal engineering including bridge design. Besides the paving work which involved 2,483,000 sq.ft. costing $816,035, the project included sanitary sewers and house connection laterals costing $48,754, and storm drain work costing $170,093, making a total contract cost of $1,034,882. During construction it was impossible to close the street entirely to traffic and the roadway was always subjected to heavy vehicular use, including a bus line.

Street and Pavement Design—The first consideration in design was the width of roadway, and finally a width of 70 ft. was selected, with an over-all width for the street roadway, sidewalk and parking or planting space of 100 ft. The 70-ft. roadway is what is commonly known as an eight-line thoroughfare, providing for one line of parked vehicles together with three lines of moving vehicles in each direction. As a matter of fact, however, this condition, experience has shown, never actually works out in practice, a maximum, generally speaking, being two lines of moving vehicles in each direction, unless the roadway is of an unusual width, where traffic is free to divide into more lines.

The highway crosses one main line interurban, standard-gage railway and two spur tracks. No attempt was made to eliminate the grade crossings of the spur tracks, but the main line grade crossing of the interurban line will be eliminated by raising the tracks to an overhead crossing. The site of the grade separation is such that a raise in grade over Pico Boulevard would cause a decided sag in the profile of the interurban line unless either a long fill or an elevated structure were built between the boulevard and the next hill west. As there has been a great deal of discussion on the elevated railway question in Los Angeles, public opinion being decidedly against the conventional type of steel structure, and as there is no elevated here now, this site seemed a logical one on which to build a sample of modern, reinforced-concrete, solid floor construction, to give the public something to compare with the usual type.

The interurban line crosses the boulevard at an angle of about 31 deg., with a double-track, five-span, solid floor, through plate girder bridge 282 ft. 9 in. long having an under-clearance of 16 ft. At the ends of the pier supporting the west end of the elevated structure, are stairways leading to loading platforms cantilevered out on each side of the elevated structure. The short section, Fig. 1, indicates the design in elevation. The reinforced-concrete elevated structure is 716 ft. long, of which about 300 ft. has loading platforms carried on cantilever brackets from the main structure, which is a double-track, three-girder deck section composed of 45-ft. spans supported on piers 5x18 ft., the outer girders being carried on cantilever brackets. The structure is designed for Coopers E-40 loading. The elevated structure has a minimum under-clearance of 14 ft. and occupies a width of 18 ft. at the street level, except at the loading platforms.

The total cost of grade separation, including track work, maintaining traffic, etc., is estimated at $300,000, of which the city is to pay $160,000.

The pavement was designed in accordance with the cross-sections, Fig. 2. The easterly half mile of the street was a roadway widening project with curbs set back 7 ft. Inasmuch as this portion of the street was highly developed by business and residence properties, it was necessary to maintain the existing sidewalk grades; the existing pavement was therefore used as a base. The remaining portion of the street was not developed to such an extent, the roadway being improved with a 20-ft. strip of concrete which was so badly broken that it would not be used as a base. The grades on this portion were readjusted, using 5½ per cent as a maximum and reimproving portions of many intersecting streets.

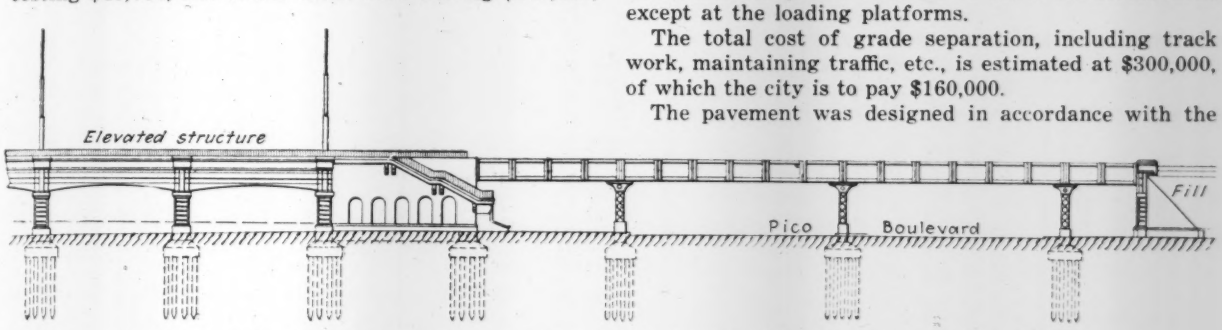


FIG. 1—OUTLINE ELEVATION OF INTERURBAN RAILWAY CROSSING OVER BOULEVARD

Throughout the improvement, standard 8-in. curb faces were used between blocks, with drainage permitting 6-in. curb faces at the B.C. and E.C. and 4-in. curb faces at the center of curb returns. The minimum radius of curb returns specified was 15 ft. at street intersections and 5 ft. at alley intersections.

Street Light Design—Particular provision was made for lighting the new wide boulevard. The lighting units, Fig. 3 were No. 1747 two-lamp union metal lamp standards with General Electric lighting unit No. 124 and No. 1124 canopy, carrying 800 cp. per post. These lights were placed between Crenshaw Boulevard and Hauser Boulevard, a distance of 9,100 ft. The posts were set 10 in. off the curb face, approximately 145 ft. apart and opposite, with conduits placed 6 in. back of the curbs and 15 in. below curb grade, and 24 in. below finished street grade at intersections. The system carries approximately two-thirds of the lighting on circuits which darken at midnight by means of a time clock, the

remaining one-third, of which one light remains at each intersection, burns throughout the night.

Drainage and Sewerage—Six miles north from Pico Boulevard and practically parallel to it, Fig. 4, is the crest of the Santa Monica Mountains. Storm water falling in the canyons has formed a number of drainage channels across the comparatively flat plain lying below. A main channel crosses the boulevard near the easterly termination of the present improvement, and runs in a generally southwesterly direction, intercepting all the other channels and emptying into the ocean several miles below the westerly termination. The most of these natural channels have been put into conduits as the result of the high degree of urban development within their respective drainage areas. Other channels whose areas have not yet reached their full development are still flowing in natural earth channels and are carried by culverts under the streets which they cross.

In the westerly portion of the improvement, the slope of the surrounding terrain is so uniform that no deep channels have developed; instead the storm water is carried in heavy quantities on practically all streets crossing Pico Boulevard.

Design of drainage facilities, therefore, resulted in four types of treatment, intercepting laterals to main-line conduits, small systems draining local areas, extension of large existing culverts and storm drains, and small surface culverts to avoid depressions across the pavements where the flow is wholly over the surface. In the last named case, drainage systems are being designed which will intercept storm water flow at points above, thus assuring ultimate freedom from heavy concentration on the boulevard itself.

In the design of the laterals located in Pico Boulevard, the main purpose served was avoidance of objectionable accumulations of water. Incidentally, the

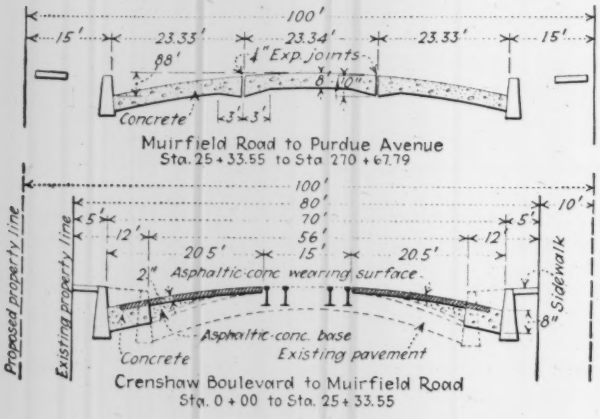


FIG. 2—SECTIONS FOR 70-FT. PAVEMENT ON PICO BOULEVARD

construction of the drain eliminated cross gutters at streets intersecting the boulevard. On account of the very flat grades prevailing in the easterly portion of the improvement, storm drains reached a large percentage of the intersections.

A total of more than 26,000 ft. of conduit of varied cross-section was installed. This conduit included reinforced-concrete box section, concrete elliptical arch section, precast reinforced-concrete pipe, and precast unreinforced concrete pipe. The box section had a maximum interior dimension of 10x6 ft.; the elliptical arch was 8 ft. wide by 7.5 ft. high; the reinforced-concrete pipe ranged from 51 in. to 24 in. in diameter, and the unreinforced pipe from 21 in. to 12 in. in diameter.

As it is customary in Los Angeles to construct all sanitary sewers and house connections before paving operations are begun, in order to minimize cutting of pavements later, a considerable length of sewers was required in connection with the Pico Boulevard job. The larger part of these sewers, however, were in an unsewered area where outlets were not available, pending the construction of a large intercepting sewer, and would have to lie idle for some time; efforts were therefore made in design to reduce the sewer construction to a minimum. Throughout most of the length of the job, alleys were available, parallel to the boulevard, in which sewers could later be built, and where unsubdivided acreage abutted on the street, the Planning Commission will later require alleys to be provided. In the remaining portion, continuous alleys were not available and the sewers had to be provided in the street.

FIG. 3—LAMP POST AND LIGHT

Located every 145 ft. on both sides of Pico Boulevard

As the country through which the boulevard passes is a rolling terrain, the sewers were mainly short and will connect to future local sewer district systems, when the interceptor is finished. This feature entailed a study of the sewerage of the entire district adjacent to the highway in order that the local sewers in the boulevard itself might properly conform to the general plan of the district and that short portions of sewers crossing the boulevard at street intersections might be laid to proper depth and grade and be of proper size to serve the future systems.

The actual length of main sewers required was 15,380 ft. and of house connections 17,705 ft., but preliminary layouts had to be prepared for an area of approximately 4,000 acres in connection with the final design of sewers for the Pico Boulevard job.

General Construction Methods—In laying out the work in this project the prime object was handling the traffic, and throughout the construction this street was kept open to travel with the minimum of delays and inconveniences.

Fills that were accessible to a roller were made in 1-ft. lifts, each lift being scarified, wet and rolled with a 13-ton, three-wheel power roller. Other fills were made in 4-ft. lifts, being thoroughly flooded by means of jets, and upon completion each fill was allowed to receive the maximum settlement before the pavement was constructed over it.

The laying of sanitary sewers and storm drains with their appurtenances was completed well in advance of the pouring of the pavement. During the construction of the elliptical arch section of the storm drain system considerable water was encountered, which was taken care of in the usual manner by employing pumps, laying a rock mattress and then pouring the invert.

As soon as the public utilities were completed on any section the contractor immediately poured the curb. Ornamental light conduits were placed back of the curb early on the morning following the pouring of the curb, previous to making the backfill necessary for curing.

FIG. 4—MAP SHOWING DRAINAGE SITUATION AT PICO BOULEVARD, LOS ANGELES

The plans called for the concrete pavement to be poured in three strips, each strip being 23.33 ft. wide, 8 in. in thickness, tapering to 10 in. in thickness 3 ft. from the edges. It was decided to pour the north strip first, then the south strip, and lastly the center. This schedule was adhered to as closely as the work would permit, throughout the job. For the pavement, the contractor employed two 27-E pavers, each mixing a seven-sack batch of a 1:2:3½ mix. One mixer worked on the east end of the project and the other on the west end. A central proportioning plant was located on each end of the job to accommodate the mixers. The fine and coarse aggregate was proportioned at these plants by means of batch hoppers and delivered to the street by means of two-batch trucks equipped with pneumatic tires. The cement was dumped directly into the skip.

Particular attention was paid to the amount of mixing water used, the desired workability being obtained with a slump of about 1½ in. During warm weather, as soon as the last belt was pulled, the surface of the pavement was kept moist by the use of a very fine spray thereby giving a minimum of checking. There was no radical departure from the general practice of making subgrade and then placing and working the concrete. At the end of the 14-day curing period the pavement was immediately uncovered and thrown open to traffic. Pouring pavement was started June 11, 1926, and was completed Dec. 7, 1926.

The section between Crenshaw Boulevard and Muirfield Road, a distance of about one-half mile at the extreme end of the job, had been paved previously but had to be widened. The existing concrete base was left intact, but the asphaltic wearing surface was removed, and after the new curb and gutter were constructed, and in the intervening gap between the old curb and the new curb, a concrete base was first poured after which all the base was surfaced with 2 in. of asphaltic concrete.

No sidewalk was constructed until the pavement was practically completed, at which time two crews were employed who did this work in a remarkably short time.

Direction—The work was handled under the direction of the writer, city engineer. C. J. Shultz, engineer of street planning, had general charge of design; Merrill Butler, engineer of bridges and structures, had charge of grade separation; L. W. Armstrong, engineer of storm drains, had charge of storm drains, and H. G. Smith, engineer of sanitary sewers, had charge of the sanitary sewer system. R. H. Rook, inspector of public works, was in charge of construction, with Mr. Harken, resident engineer of construction, immediately in charge in the field. The boulevard has now been thrown open to traffic.

Long Plate Girders in New Railroad Bridge

Plate girders 134 ft. 4¾ in. long center to center of bearings are contained in a new bridge just built by the Johnstown & Stony Creek Railroad Co. across Stonycreek River at Johnstown, Pa. The crossing leads from the main line in Johnstown to the borough of Ferndale. The river at this point has a channel width of 225 ft., but as the topography required a crossing at an angle of about 43 deg. a three-span structure was designed. Two of the spans are on tangent, and have a length of 115 ft. 7 in. c. to c., while the third, which carries the end of a curve of 350-ft. radius connecting directly with the main line track, has the girders of 134 ft. 4¾ in. length. These girders are spaced 24 ft. 8 in. because of the curve, while the other spans have 17½ ft. spacing. A footwalk is carried on brackets on the downstream side. Each long girder is 10 ft. 3½ in. deep, back to back of angles, and weighs 127,000 lb. In founding the abutments and piers, it was necessary to excavate through a 5-ft. seam of coal at one abutment and one pier, and a 3½-ft. seam at the other pier; the far abutment rests on solid slate 4 to 6 ft. thick. The bridge was built by the American Bridge Co.

Methods of Assessment for Street Paving at Flint, Mich.

Division of Property—Formulas and Tables Assist in Determining Amounts for Lots of Different Shapes

By Harry McClure
City Engineer, Flint, Mich.

LOCAL IMPROVEMENTS including sewers, sidewalks, and pavements, at Flint, Mich., are—by charter provision—usually financed "by an assessment against the owners of houses or lands to be especially benefited thereby . . . specifying the sum to be assessed and the portion of the city which they (the council) deem to be especially benefited by such improvement . . . ." With changing personnel of councils, assessing boards and other authorities, some definite, positive and continuous policy on assessments, which would eliminate personal opinions and present use of property, was necessary to prevent complaints of mistakes and inequitable assessments from year to year. For these reasons, a number of years ago, the local assessment policy was: Sidewalks; assessment of 100 per cent of cost against abutting properties in direct proportion to the frontage of each lot.

Local sewers; assessment of 100 per cent (formerly 75 per cent) of cost against abutting properties, with one "benefit" against each lot with single house restrictions (even though they may vary slightly in area or frontage), or one "benefit" against fractions of large parcels, each portion approximately equal to adjacent platted lot areas or frontage.

Pavements; assessment of 100 per cent (formerly 75 per cent) of the cost of paving against a "district" including property in a strip half a block in depth each side of the improvement, but not extending beyond the end of the improvement. In case of unplatted property, the "district" covers half the distance to the next probable future street location or a distance approximately equal to adjacent district depth. This article will deal with the details of paving assessment.

It was argued that, in addition to the property directly abutting a paving improvement being directly benefited, the property lying within one-half block of

TABLE I—SPECIMEN OF ASSESSMENT SHEET USED AT FLINT, MICH.

Street "A"
FROM—Central Ave. to Second St.
Date 4/21/26—Computed by F.D.M.
Total—Assessment $6,508.12

Sheet 1 of 2
Checked by C.J.S.

Owner	Lot	Subdivision	Table Condition	Depth Ft.	Assessment Factors	Front	Trial Assessment	Assessment × Factor 3.58931
John Smith	28	Hollywood Gardens	I—2	110	1.56472	96.4	41.96003	150.61
				—60	1.12945			
					.43527			
			IV—6	110	107.12900			
				—60	38.52720	13.6	2.62045	9.41
				50	50/ 68.60180			
					1.37204			
					1.56472			
					1.37204			
					.19268			
Wm. Jones	29	Hollywood Gardens	I—1	60	1.12945	80	90.35600	324.33
			II—3	60	.48733	16.4	7.99221	28.69
A. Strong	32	Hollywood Gardens	I—2	110	.43527	96.4	41.96003	150.61
				—60				
			IV—6	110	.19268	13.6	2.62045	9.41
				—60				
Garner Co.	33	Hollywood Gardens	I—1	60	1.12945	80	90.35600	324.33
			II—3	60	.48773	16.4	7.99221	28.69
Glen Ryan	36	Hollywood Gardens	I—2	110—60	.43527	100	43.52700	156.23
			IV—5	110	107.12900			
				—60	38.52720			
					50/ 68.60180			
					1.37204	13.6	3.29922	11.84
					1.12945			
					.24259			
Bell Tel. Co.	37	Hollywood Gardens	I—1	60	1.12945	113.6	128.30552	460.53
			III—4	60	.64212	16.4	10.53077	37.80
Bell Tel. Co.	42	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Bell Tel. Co.	43	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Bell Tel. Co.	44	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Bell Tel. Co.	45	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
John Doe	48	Hollywood Gardens	I—2	110—60	.43527	100	43.52700	156.23
Jonn Doe	49	Hollywood Gardens	I—1	60	1.12945	100	112.94500	405.39
T. Orr	50	Hollywood Gardens	I—I—4	110	.97390	125	121.73750	436.95
			II—3	73.33	.53187	41.666	22.16090	79.54
			IV—5	110	107.12900			
				36.667	54.59730	41.666	6.51323	23.38
				—73.33	52.53170			
					1.43267			
					1.27635			
					.15632			
Cons. Power Co.	51	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
			II—3	110	.69082	30	17.72460	63.62
Cons. Power Co.	52	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Cons. Power Co.	53	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Cons. Power Co.	54	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Cons. Power Co.	55	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Cons. Power Co.	56	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Cons. Power Co.	57	Hollywood Gardens	I—1	110	1.56472	50	78.23600	280.81
Cons. Power Co.	66	Hollywood Gardens	I—1	60	1.12945	100	112.94500	405.39
Cons. Power Co.	67	Hollywood Gardens	I—2	110—60	.43527	100	43.52700	156.23
							$1,813.19612	$6,508.12

NOTE—Assessment factor × frontage = trial assessment.
Trial assessment × factor = final assessment.

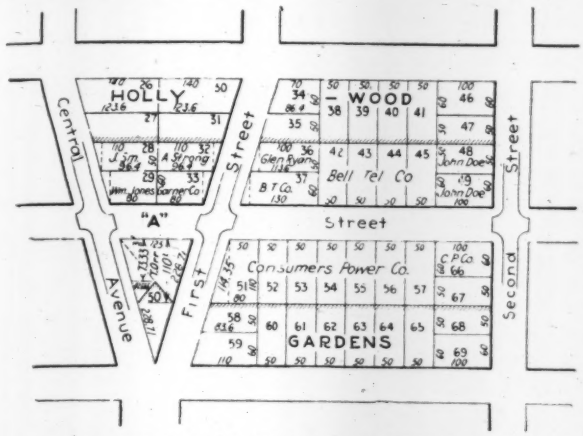


FIG. 1—TYPICAL STREET AND PROPERTY PLAN

the improvement also received benefit even though no portion touched the improvement. It was also argued that a piece of property the full half block removed received less benefit than a like piece considerably nearer; or, benefits on each unit of property decreased as the distance from the improvement increased, not on a straight line ratio, but on a parabolic line valuation.

The bare land value of the front half of any lot is more than the rear half, the front quarter several times greater than the back quarter, and it is on a similar basis that the Flint plan for assessments was developed. No account is taken of the present use of the property. From this explanation, and from Figs. 1 and 2, it will be noted that each parcel of property will eventually pay two (and only two) paving assessments; the first one as an abutting property and the second as a property located within one-half block of another improvement.

Curves were developed for the various conditions of lot sizes, shapes and locations encountered. In practically every case lots, other than rectangular in shape, can be divided into a group of triangles and rectangles, as shown in the illustration, and the formulas applied. The various formulas have all been worked out in tabular form for lots up to 500-ft. depths, so that the actual figuring of any assessment is practically completed in advance. The several cases of lot shapes and locations, shown in Fig. 1, are:

Case 1—Rectangular lot, adjacent to street line.
Case 2—Rectangular lot, back from street line but with two sides parallel to street line.
Case 3—Triangular lot, with base on street line.
Case 4—Triangular lot, with vertex at street line and base parallel to street line.
Case 5—Triangular lot, with base toward and parallel to street line, but at distance y from street line.
Case 6—Triangular lot, with vertex toward and base parallel to street line, but at distance y from street line.

Distances are measured as nearly as practicable at right angles or parallel to street lines. A sample of the assessment sheet for property shown on Fig. 1 is given in Table I.

Table II shows the trial assessment on a rectangle (Case 1) with 1-ft. frontage and for depths varying from 1 ft. to 500 ft. figured on the basis of an assessment of $1 for the first 50 ft. in depth. This table is computed by the formula

$$F = 2 - 2^{\left[\frac{50-y}{50}\right]} \qquad (1)$$

in which y is the depth and F is the trial assessment for that depth.

To find the trial assessment on a lot wider than 1 ft., it is necessary only to multiply F by the width of the lot. The trial assessment for rectangular lots which do not touch the street line (Case 2) may be obtained by subtracting the assessment of a lot whose depth is equal to the distance of the nearer lot line from the street, from the trial assessment of a lot whose depth is equal to the distance of the farther lot line from the street. It will be found that the trial assessment based on the tables differs from the total amount to be raised. The correct assessment is then obtained by multiplying each trial assessment by a factor obtained by dividing the total amount of money to be raised, by the total trial assessment as obtained above.

TABLE II—ASSESSMENT TABLE FOR RECTANGULAR LOTS

Ft.	Factor	Ft.	Factor	Ft.	Factor	Ft.	Factor	Ft.	Factor
251	1.93836	351	1.96918	351	1.98459	401	1.99229	451	1.99614
252	1.93921	352	1.96960	352	1.98480	402	1.99240	452	1.99620
253	1.94004	353	1.97002	353	1.98501	403	1.99251	453	1.99626
299	1.96832	349	1.98417	399	1.99209	449	1.99605	499	1.99803
300	1.96875	350	1.98438	400	1.99219	450	1.99609	500	1.99805

A table, showing the trial assessment of triangular pieces of property with the vertex on the street line (Case 3) is computed by the use of the following formula, in which y is the depth and F the trial assessment for that depth for a frontage of 1 ft.

$$F = \left[\frac{144.26950 - 2^{\left[\frac{50-y}{50}\right]}(y - 72.13475)}{y}\right] \qquad (2)$$

Another table, showing the trial assessment on triangular pieces of property when the base of the triangle is located on the street line (Case 4) is obtained by subtracting the amounts in a similar table from those in Table II. For the trial assessment on triangular pieces of property which lie back from the street and with the base toward and parallel to the street (Case 5) or with the vertex toward the street (Case 6), a table is obtained by multiplying the figures in this third table by the corresponding depth.

Case 5 is illustrated in Fig. 2. In the formula (3) used to obtain the assessment, A, for this condition, as given below, the term W is a factor for a rectangle whose depth is y; and f is the frontage. Further y_1 and y_2 are factors corresponding to depths y_1 and y_2 respectively, and are found from a special table for triangular lots back from the street line.

$$A = \left[\frac{y_2 - y_1}{y} - W_1\right] f \qquad (3)$$

For Case 6, also illustrated in Fig. 2, the formula (4) is used to obtain the assessment:

$$A = \left[W_2 - \frac{y_2 - y_1}{y}\right] f \qquad (4)$$

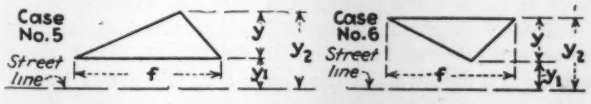


FIG. 2—DIAGRAMS OF IRREGULAR LOTS

It has been found during a period of several years, that the assessments figured on the foregoing plan, and entirely disregarding the present use to which the property is put, have been satisfactory. Assessments are easily computed by the tables and formulas. All formulas were developed in 1918-19 by G. Prenner, then a member of the engineering department staff.

Cushman Project Provides Large Storage at Low Cost

Arch Dam 250 Ft. High Raises Level of Lake Cushman Forming a Reservoir of 460,000 Acre-Ft. Capacity—Only 90,000 Cu.Yd. Concrete in the Dam

By B. E. Torpen
Superintendent of Design and Construction,
Bull Run Storage Project, Portland, Ore.

CREATING a reservoir of 460,000 acre-ft. capacity with a dam containing but 90,000 cu.yd. of concrete is an unusual accomplishment in the field of hydro-electric power development. It has been done on the Cushman power project of the city of Tacoma, Wash., located on the North Fork of the Skokomish River, where Lake Cushman, with an original area of 600 acres, lies in the center of a valley 8 miles long by ¾ mile wide. Five miles below the lake the river enters a narrow gorge 225 ft. deep that has been dammed to submerge the entire valley, raising the water 170 ft. above the level of old Lake Cushman and creating a storage basin of 460,000 acre-ft. capacity.

Rainfall and Runoff—The drainage area tributary to the Lake Cushman basin is estimated at 92 sq.mi. and the elevations range from 750 ft. above sea level at the dam site to 6,500 ft. at the summit of the Olympic Mountains.

Recorded precipitation at the dam site for 1925 showed three months with over 20 in. per month, a five months' total of 88 in., and a yearly total of 101.6 in. The runoff as measured by the U.S.G.S. was 128.92 in., 27 per cent more than the rainfall at the dam site. The average precipitation on the watershed must, therefore, have been 150 in. with a maximum of 200 in. at the extreme summits.

Such runoff is typical of western Washington streams, having a very wide range of flow and requiring large storage for regulation. The storage available for a regulated flow of 800 sec.-ft. is 380,000 acre-ft., or 65 per cent of the annual runoff and sufficient to completely regulate the stream for a 12-year period as indicated by past records.

Type of Dam—A constant angle arch dam was chosen as being the most suitable to the site, a narrow gorge between basalt cliffs. The main arch, 52 ft. thick at the bottom and 8 ft. at the crest, extends 280 ft. above the lowest point in the foundation and 250 ft. above the river bed. It has an upstream radius of 210 ft. with a central angle of 120 deg. 20 min.

The crest elevation of 250 ft. above the stream bed brings the top of the arch wall above the sheer walls of the canyon and as a consequence wing wall abutments of gravity section, 25 to 50 ft. high, are carried out on each bank. The north abutment is further extended by a low earth-fill dam with a deep concrete cutoff wall carried down into sound rock. The crest of the arch is 447 ft. long and the total length with abutments is 1,111 ft.

In the river bed, ledge rock was encountered 25 ft. below the stream level and a cutoff trench 5 ft. wide, 10 to 15 ft. deep, was excavated at the upstream side of the dam and completely up both sides. Where seams in the rock indicated the danger of excessive seepage, 20-ft. holes were drilled in the bottom of the trench and grouted under 100 lb. of air.

Contraction joints are provided in the arch at 75-ft. intervals and a system of grout pipes was installed for future grouting under pressure after the chemical heat has left the structure. Watertightness at these joints was provided by an asphaltum water seal on the upper side and a copper water seal on the downstream side.

The concrete was practically all placed by gravity and totaled 90,000 yd. River sand and gravel of excellent quality were available on a large bar directly above the dam and supplied the aggregate for the dam and power house. This aggregate was washed and screened and

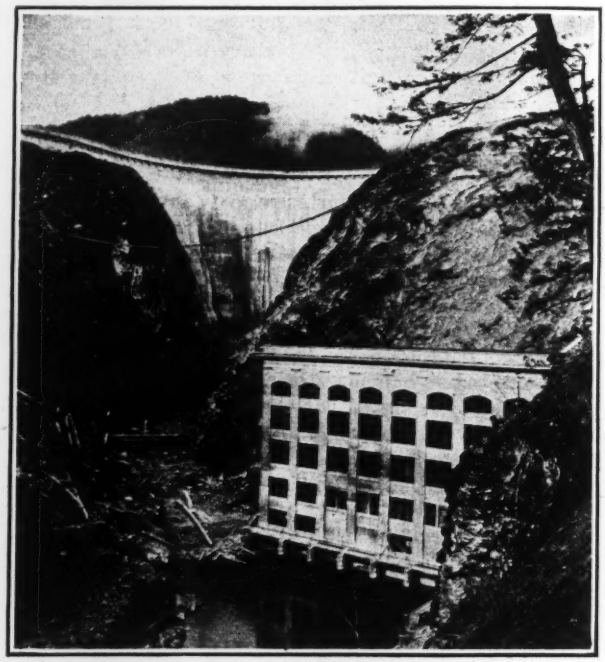


FIG. 1—COMPLETED DAM AND POWER HOUSE

mixed one and one-half minutes with portland cement for a 1:2½:5 mix designed to yield a 1,500-lb. strength in 28 days and 2,600 lb. in one year. From samples taken from the concrete in place each day, the tests indicate 1,750 lb. in 28 days and 3,000 lb. in one year.

Stresses in the arch were computed by the Cain theory and indicate a possible tension at the crown of 290 lb. per sq.in. and a compressive stress of 390 lb. per sq.in., whereas the cylinder theory indicated compressive stresses of about 250 lb. per sq.in.

Bypass Valve—Near the base of the dam a 62-in. Johnson valve is provided, with an 8-ft. butterfly valve above it in series for emergency use. Through this water can be passed to a second power house down the river at times when plant No. 1 is not in operation.

Intake Tunnel—A concrete lined tunnel 750 ft. long conveys the water from the intake 100 ft. above river bed, on the side wall of the canyon, to the power house.

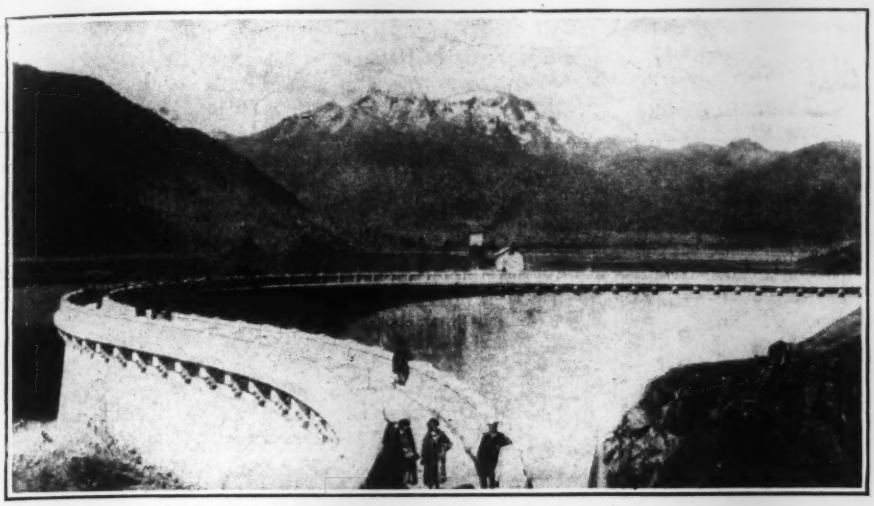


FIG. 2—UPPER PORTION OF COMPLETED DAM

Over the intake stands a reinforced-concrete tower, 85 ft. high, which carries the motors and winches for operating the trash rack rakes and two 7x12-ft. caterpillar sluice gates that control the flow of water into the tunnel. An 18-in. bypass is provided to fill the tunnel and balance the pressure on these gates, and two 16-in. cast-iron air vents prevent the formation of a vacuum behind the gates during closure.

The main power tunnel is 17 ft. in diameter with a 15-in. (minimum thickness) lining of 1:2:3 concrete. Reinforcing steel was used only near the portals where the cover was light or where the normal true circular section was deformed at branches.

At river level a 10-ft. diversion tunnel was driven to carry the stream flow during construction. A flume through the dam was also used for this purpose.

For the major part of its length the diversion tunnel was enlarged to form part of the main power tunnel. At its lower end branch tunnels 12 ft. in inside diameter lead to each of the two 24,000-hp. turbines and a third branch was excavated to act as a diversion tunnel around the power house.

The tunnel was driven by the top heading and bench method using jackhammers mounted on columns. The rock drilled easily but broke hard. Many holes were required and 5-ft. holes gave but a 4-ft. break. Six pounds of 40 per cent gelatin was used per cubic yard. Mucking was done by hand. Wood forms were used for concreting, the bottom half being poured by gravity and the upper half placed by air. Grout pipes in the spires were

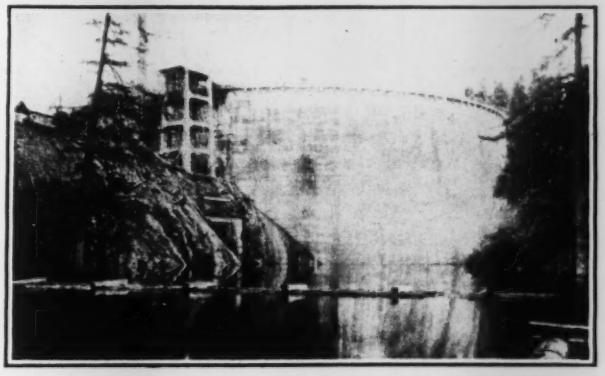


FIG. 3—UPSTREAM FACE OF DAM, INTAKE AND INTAKE TOWER

FIG. 4—PLAN AND PROFILE OF PROJECT

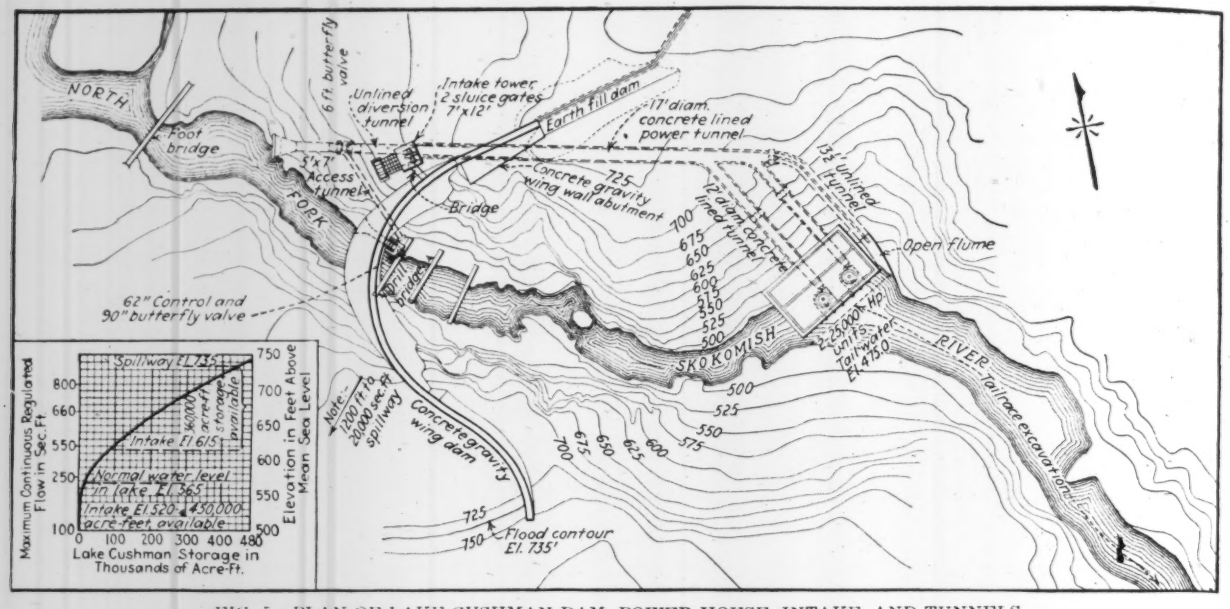

NORTH FORK
SKOKOMISH RIVER
Foot bridge
6 ft. butterfly valve
Unlined diversion tunnel
Intake tower 2 sluice gates 7'x12'
Earth fill dam
17' diam. concrete lined power tunnel
13' Unlined Tunnel
5'x7' Access tunnel
Concrete gravity wing wall abutment
12' diam. concrete lined tunnel
Open flume
Bridge
62" Control and 90" butterfly valve
Drill bridge
2-25,000 HP units
Tail-water El. 415.0
Note—12,000 ft. to 20,000 sec.-ft. spillway
Concrete gravity wing dam
Flood contour El. 735'
Spillway El. 735
Intake El. 615
Normal water level in lake, El. 565
Intake El. 520—450,000 acre-feet available
36,000 acre-ft. storage available
Maximum Continuous Regulated Flow in Sec.-Ft.
Elevation in Feet Above Mean Sea Level
Lake Cushman Storage in Thousands of Acre-ft.

FIG. 5—PLAN OF LAKE CUSHMAN DAM, POWER HOUSE, INTAKE, AND TUNNELS

used in grouting the roof to fill all pockets in the concrete to secure absolute watertightness.

Spillway—The highest flood recorded in 12 years is 12,000 sec.-ft. for one day or 24,000 acre-ft. As the reservoir area is 4,000 acres this would raise the water level 6 ft. if there were no draft during the period.

With the 62-in. Johnson valve in the base of the dam wide open and both turbines in operation, about 4,000 sec.-ft. may be discharged, which is enough to prevent overflow at the spillway. However, a spillway of ample capacity (20,000 sec.-ft.) was provided. It is located in a natural depression of the reservoir about 2,000 ft. west of the dam proper. This depression is the only pervious portion of the reservoir and consists of a glacial deposit of silt, sand, and gravel 40 ft. deep by 400 ft. in width. To prevent seepage through the reservoir rim at this point a reinforced-concrete core wall was constructed 40 ft. deep to hardpan.

From the top of this core wall was constructed a reinforced-concrete spillway apron 200 ft. wide, with floor 10 ft. below the crest of the dam. Water passing over this spillway drops 20 ft. in 100 ft. over the concrete apron, then flows down a natural creek channel in hardpan and rock to join the river again at a point one-half mile below the dam.

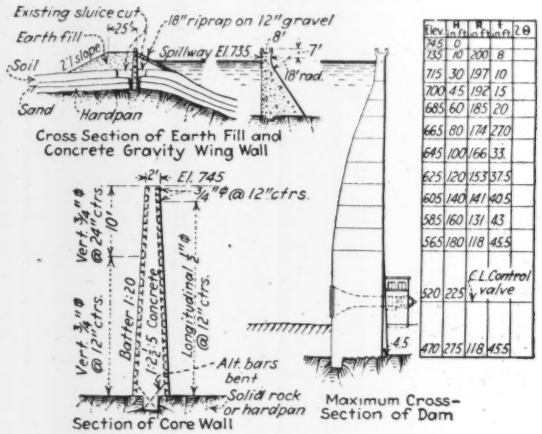


FIG. 7—SECTIONS OF LAKE CUSHMAN DAM

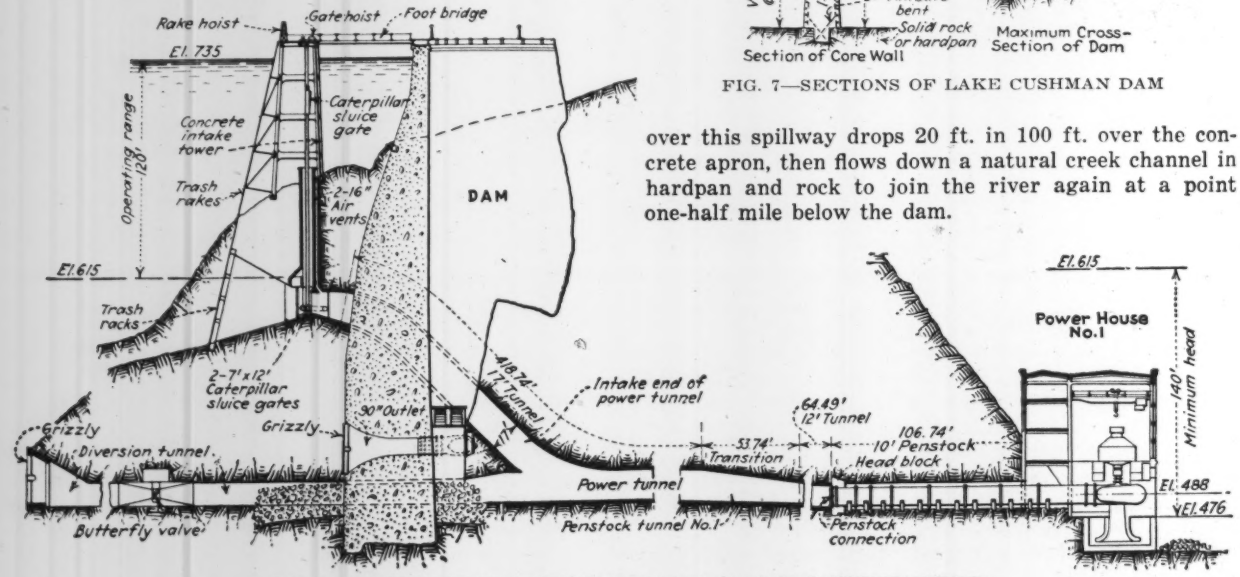


FIG. 6—CROSS-SECTION THROUGH INTAKE, DAM, AND POWER HOUSE

Penstocks—The penstocks are 127 ft. long, 10 ft. in diameter, of $\frac{5}{8}$-in. steel plate with double riveted butt-strap joints. Rivets are countersunk on the inside. A system of pipes suitable for the salt-velocity method measuring the flow of water in the penstocks was installed. Both the penstocks and tunnels were built oversize to reduce pressure rise and velocity losses.

A 9-ft. butterfly valve controls the flow of water from the penstock to the turbines, while a 6-ft. one closes the upper end of the diversion tunnel from behind the dam. The lower end of the diversion tunnel is closed by a 6-ft. pipe on which is bolted a reducer to a 2-ft. drain valve and pipe for emptying the tunnel. Drains 18 in. in diameter also are provided above the butterfly valves for draining the penstocks and below them for draining the turbine casings.

Power Plant—The turbines and generators are Allis-Chalmers units of the vertical type with a speed of 200 r.p.m. The turbines are designed for a range of head from 140 to 260 ft. with a best efficiency of 92 per cent at 210-ft. head. The nominal rating is 24,000 hp. each. The generators are three-phase, 60-cycle, 13,200-volt, 20,000-kva. units. The spiral casings are of riveted plate steel embedded in concrete and a steel pit liner and barrel support the generator. The main power house floor is just above the turbine with a mezzanine floor on a level with the base of the generators.

The floor of the draft tube chamber consists of 2 ft. of reinforced concrete on solid rock. The hydraucone piers, petticoats, and split beams also are of heavily reinforced concrete. The power house building was designed entirely of reinforced concrete, but to speed construction steel trusses were substituted to support the 4-in. concrete roof slab.

Access to Power House—An inclined railway from the ledge 300 ft. above the power house gave access to the site. It had a slope of 38 deg. and was built of 90-lb. rail on a heavily reinforced-concrete girder. The double-drum, electrically operated hoist carried 8 tons of freight on a single line or 40 tons on a 5-part line. During construction, all power-house machinery was lowered with this hoist—the largest pieces being one-half of a rotor and a 35-ton gasoline shovel for tailrace excavation.

Switch Yard—The transformers and switching yard of the outdoor type are located on the level bench above the power house. Power is stepped up to 110,000 volts and a double transmission line of copper on wood poles carries the power 44 miles to the Cushman substation in Tacoma.

Active construction work was begun in May, 1924, by A. Guthrie & Co., of Portland, general contractors for dam, tunnels and power house, and completed in January, 1926, at which time the reservoir contained 200,000 acre-ft. of water. The city installed the machinery and equipment which were ready to operate in February, 1926.

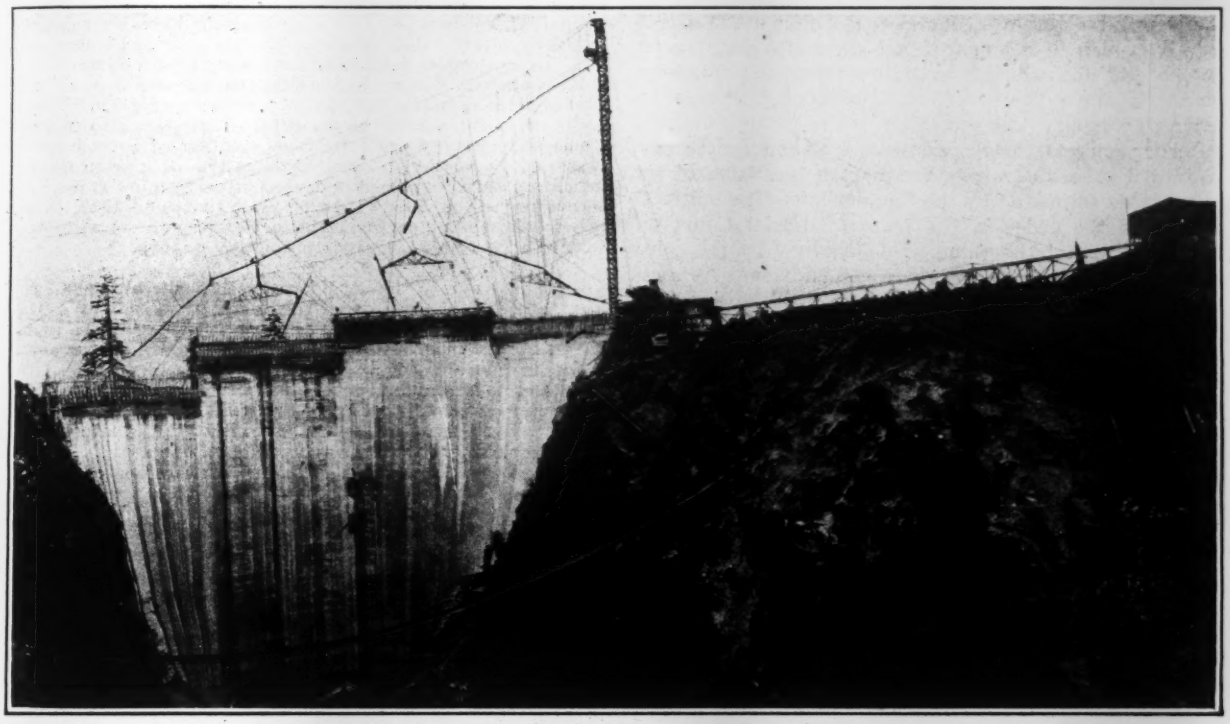


FIG. 8—CONCRETE TOWER AND CHUTE LINES OVER DAM

Future—The next step in the development of the Cushman power project will be three miles downstream, where a 220-ft. arch dam will divert the water from plant No. 1 through a 12,800-ft. concrete lined tunnel 13 ft. in diameter and steel penstocks 1,800 ft. long, to a power house at tidewater, under a static head of 475 ft., where 75,000 hp. will be developed. The cost of the two steps complete, including transmission lines, substations, rights-of-way and engineering will be about $10,000,000 and the annual output will be 300,000,000 kw.-hr.

The project was carried out under the direction of J. L. Stannard, chief engineer, with A. F. Darland as electrical engineer and the author as superintendent of design and construction. The dam was built under patents held by L. R. Jorgensen of San Francisco.

Commerce Commission Outlines Its Valuation Methods

Majority of Interstate Commerce Commission States Methods It Used in Finding the Value of Two Small Railroads—Similar Procedure to Be Used for All Other Railroads

A DECISION of unusual importance on the subject of valuation of public utility properties has been made by the Interstate Commerce Commission in placing a value upon the property of the St. Louis & O'Fallon Ry. as a basis for an order directing it to pay over to the commission half of its excess income, as required by the Interstate Commerce Act. This order was reported briefly in our news pages last week. Its importance lies in the fact, as stated by the commission, that what the commission did in that case it must do in placing a value upon all the railroad properties of the country. Moreover, the case is being made a test case by which it is hoped to get a definite decision on the subject of railroad valuation from the Supreme Court; a small prosperous railroad being chosen in order to simplify the procedure. The commission, in its order, directs the St. Louis & O'Fallon Ry. to pay over to it excess earnings based upon the value of its property as estimated by the commission. The railroad will resist the order in the federal District Court on the grounds that the value as determined by the commission is so low as to result in confiscation. As soon as the district court acts, its decision will be appealed and taken to the Supreme Court. Thus it is expected that the Supreme Court will render a decision on the method of valuation used which will affect all future railroad valuation work. Indirectly it will affect all public utility valuation. Consequently, wide interest attaches to the reasoning of the Interstate Commerce Commission as stated in great detail in the St. Louis & O'Fallon case. An abstract of its statement is given below.

The decision of the commission in the case of excess income of the St. Louis & O'Fallon Ry. and the Manufacturers Ry. (Finance Dockets 3908 and 4026, I.C.C.) was not unanimous, the commission being divided 6 to 4. The majority opinion was written by Commissioner Meyer and Commissioner Eastman wrote a concurring opinion in which Commissioner McManamy joined. Commissioners Hall, Aitchison, Woodlock and Taylor wrote dissenting opinions. The abstracts which follow are taken in large part from the majority opinion, but some of the pertinent paragraphs from the dissenting views are included.

Majority Opinion

When this proceeding was instituted we had not made a valuation of the properties of the O'Fallon or the Manufacturers' for any of the recapture periods or for any other period. The language of section 15a [of the Interstate Commerce Act] indicates the desire of Congress that the measures inaugurated be put in force as promptly as possible, and while we are required to "give consideration to all the elements of value recognized by the law of the land for rate-making purposes" . . . there is an entire lack of direction as to specific methods of procedure, and Congress apparently entertained the view that valuations under section 15a might be made in a more summary manner than valuations under section 19a.

(Section 15a of the Interstate Commerce Act is the section under which these proceedings were instituted; section 19a provides for a general valuation of the railroads).

Having in mind the provisions of section 15a, it is clear however, that the value to be determined for the purposes of recapture under that section is, like that to be determined under section 19a, the "value for rate-making purposes." Unless otherwise specified, the word "value" herein is used in the sense of rate-making value as defined and discussed in our numerous valuation cases.

The underlying engineering report, on which the tentative valuation in the 19a proceedings is in part to be based, contains estimates of cost of reproduction new, and cost of reproduction less depreciation as of June 30, 1919, based upon 1914 unit prices. These unit prices have been determined by consideration of the prices for labor and materials, and the cost of constructing and equipping railroads, in most instances during a five-year period ended June 30, 1914, but in certain other instances during periods of ten years or more ended June 30, 1914. There are also in evidence estimates by our bureau of the cost of reproduction new and reproduction less depreciation of the property which the carriers owned and used in performing transportation service on Dec. 31, 1920, 1921, 1922, and 1923. The prices used by our engineers in formulating these estimates were the 1914 unit prices, as previously defined.

* * *

We now come to the consideration of how value shall be ascertained or derived from the facts of record. We are dealing here with one small railroad. Nevertheless, what we do in this case we must in principle do for all the railroads in the United States. Whatever our decision, its effects in dollars and cents is relatively unimportant in this particular case. But, having in mind, as we must, the whole railroad situation, the decision is of the greatest consequence from both private and public viewpoints.

Commissions and courts, including the Supreme Court of the United States, have had to deal with a multitude of valuation cases, relating for the most part to local utilities —water, gas, electric, and power properties. From a composite of all these cases various principles of valuation, frequently standing in striking contrast to one another, have been evolved by interested parties according as their interest lies.

Our problem in the administration of the valuation and recapture provisions is national in its scope and in its consequences, and is affected by a vast variety of consideration that either do not enter into, or are less easily perceived in, problems incident to the regulation of local public utilities. Fundamentally the aim of the laws which we administer is the maintenance of an adequate national system of railway transportation, capable of providing the best possible service to the public at the lowest cost consistent with full justice to the private owners.

* * *

The determination of the limits within which public regulation of railroads and public utilities may lawfully function has been a matter of slow growth. Many years ago the Supreme Court held in *Peik v. Chicago, etc., Railway Co.*, 94 U. S. 164, 178: "Where property has been clothed with a public interest, the legislation may fix the limit to that which shall in law be reasonable for its use. This limit binds the courts as well as the people. If it has been improperly fixed, the legislature, not the courts, must be appealed to for a change."

Several years later it was recognized in *Railroad Commission Cases*, 116 U. S. 307, 331, that the "power to regulate is not a power to destroy, and limitation is not the equivalent of confiscation." The fundamental duty of the courts, so far as public regulation is concerned, is to prevent confiscation. So far as the states are concerned, the constitutional prohibition is in the fourteenth amendment, which provides that no person shall be deprived of property "without due process of law." So far as the federal govern-

ment is concerned, the prohibition is in the fifth amendment, which provides also that private property shall not be "taken for public use without just compensation." Obviously neither one of these prohibitions defines confiscation, and their application to public regulation of railroads and utilities is a matter of judical interpretation. Out of this necessity for interpretation grew the "fair value" rule, first enunciated in *Smyth v. Ames*, 169 U. S. 466, which lies at the root of this and other valuation proceedings.

In that pioneer case the court held that the "basis of all calculations as to the reasonableness of rates to be charged by a corporation maintaining a highway under legislative sanction must be the fair value of the property being used by it for the convenience of the public," and that "what the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience." It laid down no definite rule for determining "fair value" but enumerated certain "matters for consideration" to be given "such weight as may be just and right in each case." Later, in the *Minnesota Rate Cases*, 230 U. S. 322, 434, the court made it clear that the determination of such value is "not a matter of formulas, but there must be a reasonable judgment having its basis in a proper consideration of all relevant facts." Some of the "matters for consideration" indicated in *Smyth v. Ames* are no longer emphasized; it is fair to say that they have been discarded in the progress of thought on this problem. One of them, however, was "the present as compared with the original cost of construction," and it is this factor, rechristened "cost of reproduction new at prices current on valuation date," that we are now urged to take as the basic measure of "fair value" to the exclusion of all other factors, except to the extent that it may be augmented by an allowance for something called "going value," which is vaguely defined in many different ways.

This insistence upon cost of reproduction new at current price to the exclusion of everything else, or at least of everything that might tend to a lower value, calls for the closest scrutiny. The importance of the question which it presents has been magnified by the great increase in the general price level resulting from the World War. When we undertook the valuation work under section 19a it was a question of much less importance, but the price revolution which has since taken place has elevated it to first rank.

As is well known, our railroads and public utilities, so far as they were constructed in the last century, and to some extent in the early years of this century, were in general built and financed and administered in such a way that no dependable record was kept of either what they should have cost or what they actually did cost.

* * *

Adequate Transportation System Needed

The end in view, as we have stated, is the maintenance of an adequate national railway transportation system. Such a system, so long as it is privately owned, obviously can not be provided and maintained without a continuous inflow of capital. Obviously, also, such an inflow of capital can only be assured by treatment of capital already invested which will invite and encourage further investment. We think it must be conceded that under a system of public regulation which produces such a result private property can not be confiscated. Confiscation is a taking of property without just compensation. It is idle to contend that treatment of private property which attracts and encourages further capital ventures can be confiscatory. Furthermore, public regulation of railroads which is to any considerable degree more liberal to the private owners than is necessary to maintain good credit under reasonably prudent, economical and efficient management can not be justified. Along with the "fair value" rule this statement in *Smyth v. Ames*, should never be forgotten:

"A railroad is a public highway, and none the less so because constructed and maintained through the agency of a corporation deriving its existence and powers from the state. Such a corporation was created for public purposes. It performs a function of the state. Its authority to exercise the right of eminent domain and to charge tolls was given primarily for the benefit of the public."

More recently, in *Dayton-Goose Creek Ry. v. U. S.*, this idea was expressed as follows: "By investment in a business dedicated to the public service the owner must recognize that, as compared with investment in private business, he cannot expect high or speculative dividends but that his obligation limits him to only fair or reasonable profit."

* * *

Let us consider the effect of applying this doctrine of current reproduction cost to all railroad property in the United States. For convenience in calculation and for want of an accurate figure, we shall assume 18 billions as the value at 1914 unit prices of structures existing on June 30, 1919. The aggregate value which we used in *Ex parte 74* at the time of the general rate increase of 1920 was $18,900,000,000 for all property used for transportation purposes. But taking 18 billions as a base and applying the bureau's ratios, the value of precisely the same structures would have become 41.4 billions in 1920, 35.1 billions in 1921, 28.3 billions in 1922, and 31.3 billions in 1923. In other words, assuming a static property there would have been a gain of 23.4 billions in 1920, a loss of 6.3 billions in 1921, a further loss of 6.8 billions in 1922, and a gain again of 3 billions in 1923. These huge "profits" and "losses" would have occurred without change in the railroad property used in the public service other than the theoretical and speculative change derived from the shifting of general price levels.

Of course the railroad property in the United States during this period was not actually static. There were continual accretions. But this illustrates another angle of the problem. During the seven years 1920 to 1926, inclusive, there was an approximate net investment in additions and betterments and new construction of 4 billions. These were paid for at then current prices, all above—in many cases far above—present prices. Assuming that there has since been an average decline in unit price level of 25 per cent, a valuation under the current reproduction cost doctrine would wipe out one billion of that additional investment. The effect upon any railroad entirely or largely constructed during the period 1920 to 1926 may be imagined.

* * *

Since the price revolution brought about by the World War, the railroads have not had nor have they sought returns based upon "values" swollen in harmony with the rise in general price level. Since the passage of the Transportation Act, 1920, we have allowed them rates intended to produce, on the average, a fair return upon aggregate values far below, in all probability, the values which would have resulted from the current reproduction cost doctrine. As a matter of fact, the railroads have not earned, on the average, the fair return which the rates were designed to produce. Yet they have accepted our findings and have, except in western territory shown little disposition to seek further general increases. They have realized that to do so would be to risk conflict with inexorable economic conditions.

* * *

As shown above, investors have not been led to believe, either by our own acts or by the acts of railroad managers, that rates would be increased in an effort to secure income such as the current cost of reproduction doctrine would demand. Since 1920 the general trend of cost of reproduction new has been downward, but, on the other hand, the trend of the market prices of railroad securities has been very definitely upward. It is a matter of common knowledge that the increase in aggregate market values since 1920 has been very great. With exceptions in certain sections of the country it will be conceded that the railroads are now in better credit and financial condition, in all probability, than at any time in their history. The standard of service is clearly better than ever before. The exceptional situations are receiving consideration, with a view to their improvement. The need for improvement in such situations is due not to any deficiency in the aggregate values which we have used as a base in the general rate cases but to failure to earn a fair return upon such values.

Under such circumstances can it be said with any show of reason that the owners of this property devoted to the public service are suffering confiscation? Yet the current cost of reproduction doctrine would lead to that conclusion. It would even lead to the conclusion indeed, that a large measure of confiscation exists in the case of some of the most prosperous railroads of the country, whose securities of all descriptions find a ready market at most favorable prices.

The practical consequences of the current reproduction-cost doctrine may be viewed from yet another angle. Approximately one-third of the investment in railroad property

is represented by common stock. The remaining two-thirds is represented by bonds, notes, or preferred stock, the holders of which are limited to a fixed or maximum return. The benefits of an excess in valuation from a rise in the general price level would, therefore, be reaped threefold by the holders of common stock. The results so accruing from a heavy increase in prices, such as was brought about by the World War, would involve returns to the common-stock holders grotesque in their proportions, and particularly grotesque when considered as the limit below which confiscation would ensue. Of course, this is on the assumption that the traffic would bear the increase in freight rates necessary to produce such returns, an assumption which, as we have seen, is probably contrary to fact.

* * *

The conception of a rate base and returns thereon fluctuating up and down with changes in the level of general prices is a conception which, if carried into actual operation, could have no appeal except to stock-market speculators.

* * *

We come back, after this exploration of the field of practical results, to the thought that stability is a prime requisite in this situation, both for investors and for the country as a whole. There is nothing more disturbing to commerce and industry than the prospect of frequent and abrupt shifts in the general freight rate level; and there is nothing more disturbing to investors, as distinguished from speculators, than the prospect of frequent and wide shifts in security values. Public regulation of railroads, if it is to be successful, must rest upon a firm foundation and be guided by principles which will lend confidence to industry and investment. The current reproduction cost theory of "fair value" is utterly inconsistent with this end, and in our judgment it is equally inconsistent with any sound conception of justice.

A system of valuation for rate-making purposes based on actual, legitimate investment would have many appealing features. By reason of the replacements of units of railroad property which are continually taking place, such a system would tend to adjust itself to changes in the general price level.

* * *

Such a system would also recognize and protect every dollar invested in railroad property, whether at high prices or at low prices.

* * *

The methods which we have followed in determining the basic values of the older property have been described at length in our valuation reports under section 19a. Briefly, we have had before us the cost of reproduction new of the structural portion of this property estimated on the basis of our 1914 unit prices, coupled with the knowledge that costs of reproduction so arrived at were not greatly different from the actual original costs. We have had complete information as to the depreciation of this property, in other words as to that portion which in reality had ceased to exist because of the consumption of service life. We have had complete information as to the value of the railroad lands, based on the contemporaneous market values of adjoining and adjacent lands. We have had information, as complete as could be secured, relative to the financial and corporate history of the property, including its past earnings. We have further had such information as could be developed with reference to possible appreciation in the value of certain parts of the property because of better adaptability for use, and with reference to such other matters as the carriers desired to bring to our attention.

From this accumulated information we have formed our judgment as to the fair basic single-sum values, not by the use of any formula but after consideration of all relevant facts. In our opinion these judgments have been reasonably liberal to the carriers. In all probability they are above rather than below the amounts which would have resulted if complete records had been available and the investment theory of valuation had been employed. But the public, as represented by the government, must bear some of the responsibility for the absence of records, and it is fair, under all the circumstances, that the basic valuations should be reasonably liberal.

In more than 400 reports relating to the value of individual railroad properties we have said :

The estimates of cost of reproduction covered by this report are based upon what is referred to herein as the 1914 level of prices, while the present values of the common-carrier lands covered by the report are based upon the fair average of the normal market value of lands adjoining and adjacent to the rights of way, yards and terminals of the carrier, as of valuation date. This discrepancy will be removed when the commission adjusts to later dates, in accordance with the requirements of the Valuation Act, the final value herein reported.

* * *

When it comes to bringing these basic valuations so arrived at down to any subsequent date, however, no good reason appears for doing more than making the necessary adjustments to reflect the property changes which have since occurred and which have been fully reported to us, and to reflect any further depreciation of the property. By the adoption of such a method of bringing values down to date we shall achieve the stability of rate base which we have found to be essential to public regulation.

* * *

It should not be forgotten that the value to be used as a rate base in the process of public regulation is only one element in the constitutional protection against confiscation of property. The other element is a "fair return" upon such value. Paragraph 3 of section 15a directs us to determine from time to time and make public "what percentage of such aggregate property value constitutes a fair return thereon," and it is definitely and specifically provided "shall give due consideration, among other things, to the transportation needs of the country and the necessity (under honest, efficient, and economical management of existing, transportation facilities) of enlarging such facilities in order to provide the people of the United States with adequate transportation." Whatever the rate base, we are enjoined and required to so adjust the "fair return" that investment in railroad facilities will be encouraged and promoted and the companies maintained in good credit. If this end be accomplished, there can, in our opinion, be no confiscation.

In this connection it is significant that when the legislation of 1920, of which section 15a is a part, was under congressional consideration there was offered in behalf of the carriers a proposed bill in which their recorded investment in road and equipment was made the sole element in the determination of the rate base.

* * *

It has been suggested that while it may be going too far to take current cost of reproduction as the basic measure of value, some weight ought to be given to changes in general price levels. Under the method outlined above we do give weight, to such changes in so far as they have been reflected in prices paid for new construction or replacements, and we value lands at their prevailing market values.

* * *

Value rests upon a number of elements. The value of the property of railroads for rate-making purposes, which is construed to be the value of property devoted to common-carrier purposes upon which common carriers are entitled under the law to earn a fair return, approaches more nearly the reasonable and necessary investment in the property than the cost of reproducing it at a particular time.

Concurring Opinion

To the opinion given by the majority, Commissioner Eastman added the following:

I concur in the results reached in this case. They are, I believe, somewhat too favorable to the carriers, but not to an extent which warrants dissent.

It is said that the report and the conclusions reached therein disregard the law as laid down by the Supreme Court. I do not believe that this is fairly descriptive of the situation. The court, as I read its decisions, has very wisely avoided a crystallization of the law with respect to the limits set by the Constitution to the public regulation of undertakings affected with a public interest. There is no controlling decision under the statute which here governs our action, nor any other decision which can fairly be regarded as conclusive of the vital issue in this case. But let us assume for the sake of argument that there is the apparent disregard which is alleged. Where does our duty lie?

* * *

In determining such questions knowledge of pertinent facts and an experience which makes it possible to visualize

the probable results of a particular public policy are quite as important as familiarity with the law books. It is an instance in which the law is influenced if not governed by the facts. When, therefore, the question relates to the constitutional limits of the public regulation of railroads, an intimate knowledge of railroads, of their relations with and their importance to the shipping and investing classes and to the public generally, and of their past history and future prospects becomes of the highest consequence. Such knowledge it is the peculiar duty of this commission to acquire. As to such matters it occupies a daily front seat upon the stage, while the Supreme Court of necessity is only an occasional visitor in the balcony. Whether the commission has the ability to make the best use of its opportunities for knowledge may be open to debate, but at least is must proceed upon that assumption.

I can not avoid the conclusion that the commission would be derelict in its duty in this case if it should confine its attention, so far as the fundamental law is concerned, to past utterances of the court in more or less analogous cases and should neglect the illumination which is thrown upon the law by its own intimate knowledge of transportation affairs and problems. I feel sure that the Supreme Court is itself desirous that we should speak both frankly and fully on these matters. *United States v. Los Angeles & Salt Lake R.R. Co.*, decided February 21, 1927, may perhaps be deemed an invitation to that effect. After the court has heard what we have to say it may decide that our conclusions as to the fundamental law are erroneous, and that will end the matter; but certainly we ought not to deprive the court of the help which it may gain from the special knowledge which it is our duty under the law to acquire. The report in this case seeks to impart this knowledge, so far as it seems pertinent, respectfully but candidly.

The "fair value" rule originated in *Smyth v. Ames* in an endeavor to fix the limit beyond which public relations could not justly go. It may fairly be said that the Supreme Court was guilty of confusion of thought in that case, particularly in the use of the word "value." Obviously, the market value of a property is dependent largely upon its earning power, present and prospective, and cannot be used as a basis for determining what that earning power shall be. It follows that "fair value for rate making purposes" is not "value" in the ordinary sense of the word.

* * *

I digress at this point to express a firm conviction that acceptance of the current cost of reproduction doctrine would in its ultimate result be disastrous to private operation of railroads and public utility, not only in periods of low prices, but in high price periods as well.

In his support of this conviction Mr. Eastman quoted from a unanimous report recently made by the Department of Public Utilities of Massachusetts to the general court of that commonwealth, in which it was stated that if gas and electric companies are entitled to charge rates upon a fair value of their property, based upon the cost of reproduction less depreciation, and if these findings were subject to review in each instance by the federal court, the people of the state will conclude that regulation by such methods is too cumbersome to be tolerated, and that they will resort to public ownership. Mr. Eastman said, further:

But there is an even stronger objection to the use of current cost of reproduction as a means of compensating for the decline in dollar purchasing power. As the report herein indicates, two-thirds of the railroad securities outstanding bear a fixed or maximum rate of return, and their holders could in no way benefit from a swollen rate base. Not only would all the benefit accrue threefold to the common stockholders, but they would retain in full measure the advantage of the opportunity to pay the indebtedness of their companies in depreciated dollars. The result would so conflict with principles of justice as to border on the ludicrous. The place to make allowance for the depreciated gold dollar, if it can be shown that justice requires an allowance, is clearly in the rate of return, rather than in the rate base.

* * *

I come now to the points in which I differ with the discussion in the report. I am wholly persuaded that the best and fairest rate base or "value for rate-making purposes," as well as the simplest and most practicable, is the honest and prudent investment in existing property. So far as structures are concerned, the report in this case adopts much the same principle.

More important, however, is the use of present value of lands. Here the report departs from the principle followed in the case of structures and uses, in constructing the rate base, not the actual or approximate money outlay in the lands, but an amount based on current market value of adjacent lands. Here [in the O'Fallon case] the consequences of this deviation from principle are not important, but in other cases they may be of vital importance, particularly where the railroads have extensive land holdings in the heart of great cities.

Dissenting Opinions

Commissioner Hall wrote a dissenting opinion in which Commissioners Aitchison, Woodlock and Taylor joined. He said, in part, as follows:

At the risk of appearing to lack vision we venture the reminder that the function of this commission is not to act as an arbiter in economics, but as an agency of Congress, to apply the law of the land to facts developed of record in matters committed by Congress to our jurisdiction. We may, indeed, in our annual reports to that body recommend needed changes in legislation, but we may not make those changes ourselves.

* * *

The issue presented is, as stated, of profound importance in its effect upon the public welfare and policy. In essence the problem is not novel and frequently has been passed upon by commissions and courts. The only real difficulty or obscurity is as to the value of the property. All other questions are either ministerial in their nature or present simple issues of fact. The determination of value in cases involving the returns from rates has been before commissions and courts almost continually for nearly thirty years and the consensus of authority has evolved certain principles, now well understood, even if many others remain unsettled and uncertain. Among these certain and established principles are (1) that the value is to be ascertained as of the time of the inquiry, and (2) that proper consideration must be given to all relevant facts, including the enhancement of material and labor costs of property as compared with past values or costs.

* * *

It follows that, under the law of the land, in determining the value of the O'Fallon for any of the purposes contemplated by either section 19a or section 15a, the valuation and the recapture provisions of the act which we administer, we must accord weight in the legal sense to the greatly enhanced costs of material, labor and supplies during the periods of inquiry, here the recapture years, over those prevailing in the pricing period. The majority in according no weight to such evidence disregard highly relevant facts, established by competent testimony and undisputed.

The use, as a common starting point, of 1914 unit prices in arriving at 1914 reproduction cost of carrier structures then in service is not here challenged. The dissent is from the use made of them in determining value in 1923 without application of corrective factors or cure of recognized discrepancies in the adjustment of values which we should now make to the later date, the date of inquiry or recapture. In this the departure by the majority from our hitherto-declared purpose is unmistakable. If the majority, while developing with manifest earnestness and sincerity the reasons by which they are persuaded, had nevertheless recognized the constraint of the law thus far declared and reached conclusions in harmony with it, nothing would have been lost in the presentation, and where we were in error the Supreme Court could have set us right. If the law needs change, let those who made it change it. Our duty is to apply the law as it stands.

Commissioner Aitchison in dissenting said:

I desire to add a few words to the foregoing expression. In much that is stated by the majority as to the effect of the valuation rule contended for by the carriers, I unreservedly concur; and my dissent as expressed by Commissioner Hall on purely legal grounds does not indicate non-

concurrence as to these other important considerations, chiefly economic in their character, so forcefully discussed by the majority.

Further dissenting opinion was given by Commissioner Woodlock in which he said:

I think it desirable to advert briefly to certain matters in the majority report, in addition to those dealt with by Commissioner Hall, in whose expression I have concurred. With the majority's main arguments of an economic nature I am in fundamental disagreement. The contention that stability of the investment in railroad property is best attainable by irrevocably linking that investment to the dollar seems to me to be, on its face, quite untenable. The dollar is valuable only because of the commodities that it will buy. Its purchasing power is notoriously characterized by great and continuous instability. The investment theory of value urged by the majority equates railroad property with the dollar. The principle of valuation expressed in the decisions of the Supreme Court equates railroad property with all other forms of property. This is the only real and effective stabilization. For the majority's theory to produce effective stabilization of railroad property it would be necessary, first, to stabilize the dollar.

Toronto's Additional Water Supply To Cost Over $14,000,000

Lake Intake Tunnel with Steel Pipe Extension, Treatment Works, Land Tunnel, Pumps, Force Mains and Reservoirs

A TUNNEL beneath Lake Ontario having a capacity of 360 U. S. m.g.d., with steel conduits, extensions to a submerged inlet in 52 ft. of water, pumping and purification plants at the shore end of the tunnel, a long filtered water tunnel extending the entire length of the water front to the present main pumping station and beyond it to a new pumping station, a covered distributing reservoir, an elevated tank, and various force mains and other connections with the present distribution system, compose the improvements to the waterworks of Toronto, Ont., for which plans are now being drawn. The lake and land tunnels, which will be in shale rock, have a combined length of 52,800 ft., or ten miles. The estimated cost of the improvements is $14,317,000.

Of the ultimate three steel lake conduits between the lake shaft of the tunnel and the intake exit, only one (150 U. S. m.g.d. capacity) will be built at the start. The original filters will have a capacity of 125 U. S. m.g.d., with provision for ultimate duplication, but with the aid of a clear water reservoir and storage reservoir they can supply peak loads of over 150 U. S. m.g.d. Part of this filtered water will be used to supply the eastern part of the city, by means of high-lift pumps, and part will flow westward, by gravity, to the present (John St.) and the new (Parkside Drive) high-lift pumping stations already mentioned. The land or filtered water tunnel will have a capacity of 168 U. S. m.g.d. up to the John St. station, and 60 U. S. m.g.d. the remainder of its length. For the present, at least, no pumps will be added to the John St. equipment, except the booster pumps for equalizing hydraulic conditions, mentioned in one of the footnotes to the map, Fig. 2.

The John St. station now supplies the entire city with water from the slow sand filters and the drifting sand type of mechanical filters located on the island across the harbor (see map). These filters have a combined capacity of 125 U. S. m.g.d., and the John St. station can deliver 127 U. S. m.g.d. The net combined effect of the new works, for immediate installation, will be limited by the capacity of the new filtration plant and equalizing clear-water reservoir and storage reservoir to the annual average of U. S. m.g.d., which will be for distribution to the new eastern, old central, and new western pumping stations. Until the new filters are duplicated, the new and old supplies combined will total the annual average of 180 U. S. m.g.d., and thereafter the total would be 270 U. S. m.g.d.

The installation covered by the estimate of $14,317,000 will meet the probable needs of Toronto until 1953, when the population may be 1,200,000. Duplication of the initial filter plant and accessory pumps and pipe connections would provide for more people, or 1,800,000 in all.

The foregoing outline is based on a report submitted in May, 1926, by H. G. Acres, Niagara Falls, Ont., and William Gore, of Gore, Nasmith & Storrie, Toronto, who were engaged early in 1927 as engineers to carry out their own recommendations. Funds for the project are already available. Under date of April 4, Mr. Gore informed *Engineering News-Record* that additional borings are proposed with the idea of a possible extension of the lake tunnel to the intake, in place of the steel conduits proposed in the report.

The location of the new intake at the eastern end of the city rather than near the present island intakes off the center of the city, or some point to the westward, was chosen after careful study of the effect of land drainage, the city sewer outlets, lake currents and winds, upon the quality of the water, and also of the slope and character of the lake bottom in relation to the new intake. As to natural or land drainage, a map is reproduced from the report to show how the Don and Humber Rivers, and other streams farther west, drain an immense area into the lake, whereas to the eastward only a few short streams, with a small combined drainage area, drain into the lake. Moreover, the net effect of lake currents and winds favors the intake location chosen, even though the principal outfall sewer, discharging effluent from settling tanks, is located only

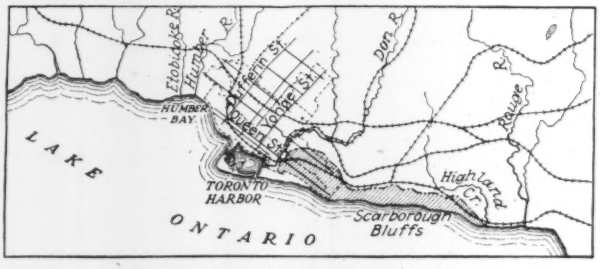


FIG. 1—LAND DRAINAGE INTO LAKE AT AND NEAR TORONTO

Smallness of hatched area at right or east and shortness of streams draining into lake from that section compared with the large area draining to lake farther west, combined with study of winds and currents led to location of new water intake off shore to east instead of alongside old intakes out from Toronto Harbor or farther west. See other map (Fig. 2) for location of old and new water intakes and outlet from sewage-works.

3 miles west of the new intake. The report already mentioned points out the possibility of treating the sewage to lessen its burden on the filter plants. The report lays stress upon the advantages of the clearer supply that may be expected at the new intake as compared with that from the present off-island intakes or any intake to the westward.

Against putting the new intake off shore from the island is the experience with the existing intakes, which have been seriously endangered by shifting sand. The bottom here falls off much more rapidly (see contours, Fig. 2) than at the location which has been chosen for the new intake.

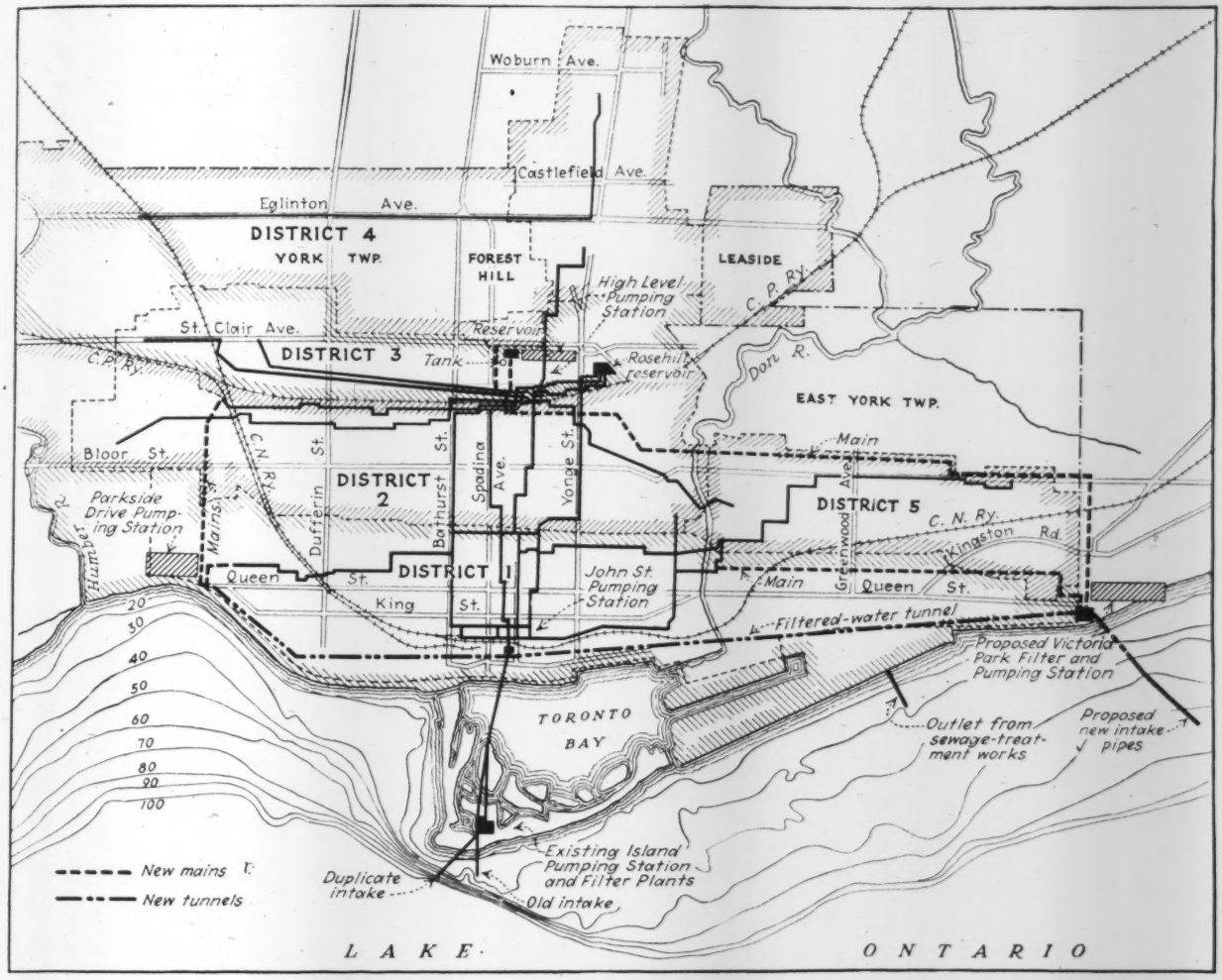


FIG. 2—NEW INTAKE, PUMPING AND FILTER PLANTS, RESERVOIRS, TUNNEL AND FORCE MAINS FOR TORONTO

Lake Intake Tunnel and Steel Conduits—From combined high- and low-lift pumping station in Victoria Park tunnel 10 ft. in diameter and 3,300 ft. long with capacity of 360 m.g.d. leads to submerged shaft in 30 ft. of water from which, ultimately, three 8-ft. steel pipes, 4,250 ft. long, with capacity of 150 U. S. m.g.d., will lead to a submerged intake in 52 ft. of water; only one pipe to be laid at the start.

Low-Lift Pumps—Water from intake will pass through revolving screens to four low-lift, electric-driven turbine pumps with combined capacity of 162 U. S. m.g.d. (two each 54 and 27 U. S. m.g.d.).

Treatment Works—Coagulation basin and mechanical filters of 125 U. S. m.g.d. capacity, with provision for duplication. Chlorination apparatus. 15-U. S. m.g.d. clear water reservoir.

High-Lift Pumps — Electric-driven turbine pumps with ultimate combined capacity of 250 U.S. m.g.d., spares being provided so as to meet peak load of about 175 U.S. m.g.d.; immediate installation of only 75 U.S. m.g.d., sufficient to meet peak load for area east of Don River until about 1945.

Force Mains—Besides land tunnel to be mentioned, a 42- and also a 36-in. force main will lead from Victoria high-lift pumps to existing trunk mains, giving capacity to serve district east of Don River until 1945.

Filtered Water Tunnel—In two portions: (1) 7-ft. diameter with capacity of 168 U. S. m.g.d. extending 30,500 ft. to present John St. high-lift (which now delivers water from the Island filter plants), thus providing, with aid of high-lift pumps at John St., an independent source of supply sufficient for area west of Don River until 1945; (2) 6-ft. tunnel 19,000 ft. long with capacity of 60 U.S. m.g.d. to a new high-lift pumping station at Parkside Drive. This portion of the tunnel may deliver water from either the old or new sources, or both.

John St. Booster Pumps—Low-lift electric-driven booster pumps to make present supply from Island filter plants available to present John St. and new Parkside Drive high-lift pumps under same hydraulic conditions as the new supply from Victoria Park filters.

Parkside Drive High-Lift Pumping Station—A 60-U. S. m.g.d. high-lift electric-driven turbine pumping plant. Part of this plant will give pressure suitable for District 2, in parallel with existing pumps at Cottingham St. high-lift station, balanced by proposed new 60-U. S. m.g. reservoir; other part of initial plant is for pressure suitable for operation in parallel with the John St. station, balanced by Rosehill reservoir.

Parkside Force Mains—(1) A 24-in. cast-iron main to connect with extremity of existing main running west from John St. through District 1; (2) A 42-in. steel main to the north to connect to present mains in District 2.

Storage Reservoir—A 60-U. S. m.g. covered reinforced-concrete reservoir at St. Clair Ave. W. and Spadina Road, to serve Districts 2 and 5.

Tank — Adjoining new reservoir a 360,000-U. S. g. ornamental elevated storage tank to supply District 3.

Connections — Necessary connecting mains to and from reservoir and tank.

Setting Form Points on Constant-Angle Arch Dams

A Method Well Suited to Dams Exceeding 100 Ft. in Height Expedites and Simplifies Engineer's Field Work

By B. T. Millard
Construction Engineer, R. C. Storrie & Co., Storrie, Calif.

CONSTANT-ANGLE arch dams are built with curved surfaces whose radii vary from base to crest and hence special problems are introduced in laying out the work for the form carpenters. It is necessary to have a system whereby form points that have to be set daily can be located without delay as pouring of concrete proceeds. Since the face at any elevation has a different curvature than at any other elevation the engineer must set points for the carpenter for every lift. These points must be set in a minimum of time to avoid unnecessary delay and extra cost in form work.

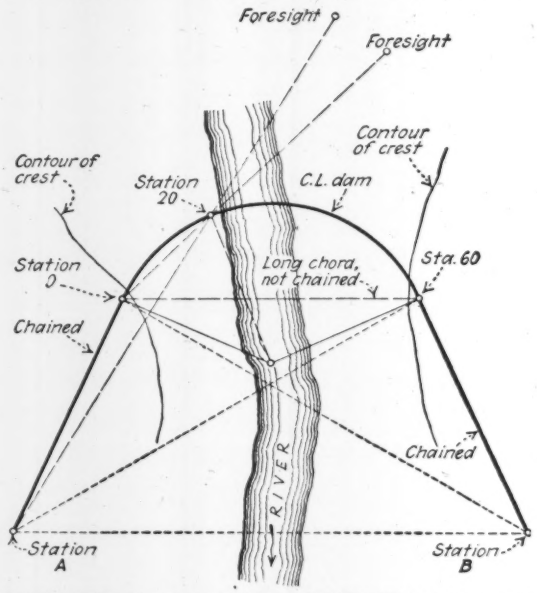
In smaller dams of the constant-angle arch type it is usually found most convenient to lay out all the curve centers on the ground or upon a platform built for the purpose. The points are then set by the use of transit and tape. With the transit occupying the proper curve center for the elevation at which points are being set and the slope angle having been predetermined and noted it is a simple matter to strike an arc with the slope tape, setting a series of studs above the previously poured concrete exactly to the new batter about every 10 ft. of form length. The other studs can be warped in between and the sheeting run up. The upstream face at any elevation is concentric with the downstream face except near the abutments where the dam is thickened by compounding the curve of the downstream face.

This simple method has been used successfully and has given a remarkably smooth face on dams of this type up to 110 ft. in height. On constant-angle arch dams of greater height where the slope angles become so great as to prohibit the use of this method or where the various centers are inaccessible the writer has used successfully a method which involves considerable office computation but very little field work.

Using this method on the Bullard Bar dam in California, a constant-angle arch 183 ft. high and 550 ft. long on the crest, it was found possible with one transitman and two chainmen to set form points for any section less than 100 ft. long in one hour. The construction of that dam was unique in that one-half the structure was built from bedrock to crest before the water was diverted from the river channel. Concreting was started in December at a time when the river varied from 300 to 10,000 sec.-ft. The result was half a dam standing 180 ft. high before any points were set for the other half. This 180-ft. vertical depth of course prevented surveying along the center line of the dam. For this case the method described was invaluable.

The center line curve at the crest was convenient as a reference, being a line on the dam for its entire length. This is a simple curve with a fixed radius. The station marked 0 on the accompanying sketch was taken on one abutment, clear of the excavation and of other work. This station was monumented, as was also station *A* on a tangent to the curve at station 0 and distant about 400 ft. from it. Station 60 was set by triangulation from station 0 and station *A* and was a point on the curved center line of the dam a distance of 600 ft. along the arc. This station 60 was monumented as was also station *B* along the tangent to the curve at station 60. The distances from station 0 to *A* and from 60 to *B* were carefully chained and all angles were carefully checked, this being the base of all work. The diameter along the long chord from 0 to 60 was not measured directly.

The co-ordinates of these points were computed, using the co-ordinate system which had been established by the preliminary staking out of the structure. These were based on true meridian with the origin at a public land survey corner. The co-ordinates could have been any local system. The center of this center line of crest



POINTS SET IN LAYING OUT CONSTANT-ANGLE ARCH

curve consisted of a white spot on a wire suspended over the river. The white spot was located both by co-ordinates and by triangulation.

A table was prepared giving the chord length for any arc from 5 ft. to 100 ft. of true arc distance. The center line curve was laid on the ground using 10-ft. stations called 1, 2, 3, 4, etc., the true chord lengths and deflection angles at 0 and 60. The angle at *A* with a foresight on 0 to every 10-ft. station was computed. With these data recorded in the field book it was possible to establish any 10-ft. station on the center line of the dam by intersecting transit lines from station 0 and station *A*. Having any point on the center line curve and with a backsight on 0 or 60 the portion of the curve desired was readily laid out. The transit lines from 0 and *A* intersecting at station 20 (near the center of dam) were marked with permanent foresights. This station could always be set without turning angles with the transit.

The entire layout having been previously plotted on a scale of 1 in. to 10 ft. the outline points for excavation purposes were laid out by scaling along a radial at the various stations, and by sighting toward the center suspended on the wire over the river.

For forms, the distance to the face of the dam along the radial from the center line curve at every 10-ft. station and for every 10-ft. contour was computed. This involved a considerable amount of office work, using a

calculating machine. It was found in checking that the scaling on the scale 1 in. to 10 ft. for all of the excavation points had been correct within one-tenth of a foot.

This system made it entirely possible to lay out any section of the dam without carrying the center line over any other section. The intersecting transit lines from 0 and *A* having such an acute angle between them for the first 100 ft., the curve from 0 to 10 was usually run out from 0 with deflection angles and tape. For the central portion of the dam these intersecting lines gave very good accuracy.

The routine of setting form points from day to day as alternate sections of the dam were raised, allowed the center line to be run back and forth from stations established the day before and still uncovered with concrete. There were times, especially near the base of the dam, when it yas absolutely essential to use the intersecting transit lines to get a start on the curve. The center of the curve which was marked on the wire suspended across the river was always used as a check on the accuracy, but was never used as a backsight.

The actual form point given by the engineers for the carpenters was a nail driven into the freshly set concrete on the radial at each station and the proper distance from the center line for the face of the dam at some even foot of elevation above. Using the transit as a level and bench marks which had previously been established by wye levels off of the dam near every 10-ft. contour, the elevation of each of these nail points was determined and the vertical distance computed up to the even foot contour for which it had been set. This "rise" was marked in feet and inches for the carpenters. The form was then set by plumb bob and tape over these points. Form panels 4 ft. high by 6 ft. long were used on this job successfully.

Tests of Welds at Lehigh University

A NUMBER of tests of welded joints and members were made at Lehigh University on April 4 in the course of a welding symposium held under the chairmanship of Prof. R. J. Fogg. The tests followed an introduction by Prof. Bradley Stoughton discussing the various processes of welding. The tests were planned to throw light on the physical characteristics of joints made by the several processes. They included tension tests of welded bars, a test of a square frame of I-beams and H-columns, and a test of a trussed joist.

The tension test results on bars are summarized in the adjoining table. It will be seen that a number of the joints closely approached the strength of the unwelded bars and that excellent uniformity was attained. Tests of two spot-welded plates gave considerably lower results.

In the frame test, load was applied to the upper member of a frame composed of two 10-in. H-columns and two 3-ft. lengths of 12-in. 31.8-lb. I-beam. The ends of the beams were not specially prepared for welding, but were simply cut square and butted against the columns and then welded. It was concluded after the tests that better results might have been obtained had the edges been chipped or beveled before welding. The maximum load carried was 220,000 lb., and failure occurred by buckling of the web of the upper beam under the load of the ram. Stiffeners had not been provided here because so high a load had not been expected. In the course of the failure, the joint at one end of the beam pulled away from the column at the top, the crack extending 7 in. down.

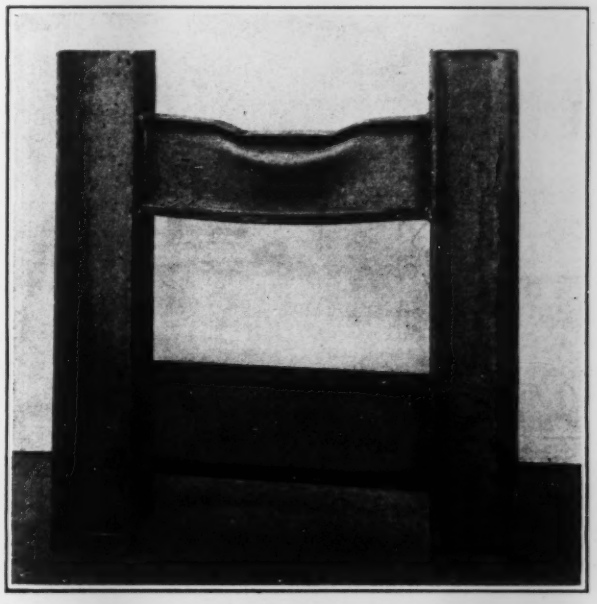
LEHIGH TESTS OF WELDED BARS

(Steel about 0.25 per cent carbon. Bars machined after welding.)

Tension Tests of ¾ x ½-*in. bars*	Max. Load	Max. Unit Stress Lb./Sq In.	Remarks
Unwelded bars (two tests)	20,500	62,500	
	20,300	62,000	
Gas-welded bar	17,300	52,700	Broke at weld
Metallic electric-welded bar	17,570	53,500	Broke at weld
Carbon electric-welded bar	19,890	61,100	Broke at weld
Thermit-welded bar	19,680	60,000	Broke at weld
Resistance butt electric-welded bar (two tests)	20,210	61,600	Broke 2 in. from weld
	20,920	63,780	Broke 4 in. from weld
Gas-welded bar	17,950	54,860	Broke at weld
Tension Tests of Spot-Welded Plates			
Two ¾-in. spots, 1¾ x 0.167 in.	4,870	41,600	Broke at weld
Three ¾-in. spots, 2 x 0.045 in.	3,420	38,000	Broke at weld

The test of the trussed joist resulted in buckling failure due to failure to brace the top chord, and did not give information on strength of welds.

In the course of the symposium papers were read on the present status of arc welding, on welding of structural steelwork, and on the present superiority of riveting for structural work, the two last items constituting a pro and con discussion between advocates of welding and of riveting.



WELDED FRAME AS DISTORTED IN TEST

12-in. I-beam 3 ft. long welded to the flanges of two 10-in. H-columns. Maximum center load carried, 220,000 lb. Crushing of beam due to absence of stiffeners. Left-hand welded joint pulled away from column to slightly more than half the depth of the beam.

Large Reservoir Under Construction

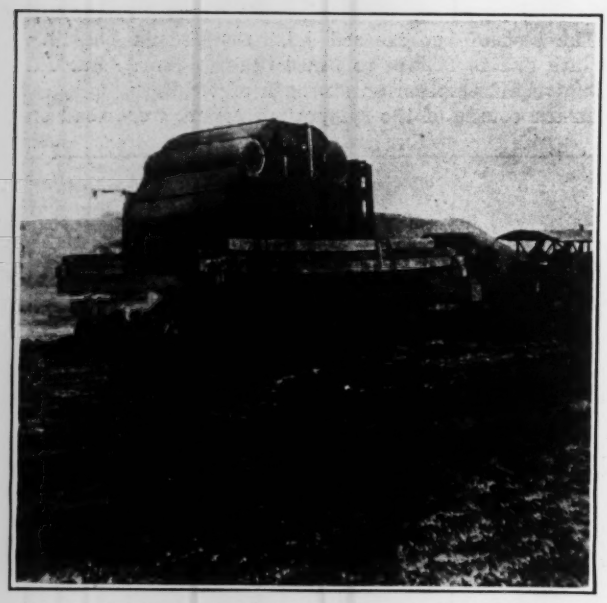
A reservoir of 2,485,000 acre-ft. capacity at spillway level, and about 3,000,000 acre-ft. at 5-ft. flashboard level, is under construction in Queensland, Australia. It is the Nathan reservoir, which is to serve irrigation. At spillway crest level it is 153,000 acre-ft. smaller in capacity than the Elephant Butte reservoir, New Mexico, which supplies water to the Rio Grande project of the U. S. Bureau of Reclamation, but with the flashboard storage it will be larger and thus will be one of the largest irrigation reservoirs in the world.—*New Reclamation Era.*

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Transporting a 25,000-Lb. Boiler Across a Dry River Bed

OIL field developments require the transportation of very heavy equipment over poor roads or no roads at all. The accompanying illustration shows a 25,000-lb. portable boiler being hauled across the South Canadian River in the Texas Panhandle by the Phillips Petroleum



TRANSPORTING A 25,000-LB. BOILER BY MOTOR TRUCK
Note deflection of supporting beams.

Company. The material was quicksand. As will be noticed, a crawler tractor was necessary across this 4,000-ft. stretch in addition to the motor truck.

The method of mounting the boiler is interesting. An ordinary two-wheel trailer was used and the boiler suspended between the bolster of the trailer and blocking on the frame of the truck. Four 10x10s on each side were spanned between the bolster and the blocking and the boiler was suspended from these with chains.

High-Strength Concrete Obtained in Test Pile in Three Days

By L. K. White

Resident Engineer, Kansas Highways Commission, Wichita, Kan.

HEATING the sand and mortar, mixing for 5 min. with ordinary portland cement, and using a minimum amount of water, resulted in a high-strength concrete in a test pile used on a bridge constructed in Sedgwick County, Kansas.

The pile was 25 ft. long, 14 in. square in cross-section, tapering in 5 ft. at one end to 8 in. square at the tip. Four 1-in. longitudinal rods tied with ¼-in. hoops comprised the reinforcing. A jet pipe of tin 2 in. in diameter was placed through the center of the pile.

The specifications on the job required precast concrete piles to be made of 1:2:4 concrete, cured for 30 days, at a temperature of not less than 60 deg. F. It was to avoid this 30-day delay that methods were employed to attain a high-strength concrete early.

Sand having a fineness modulus of 2.53 was heated; a standard brand of portland cement was used; the field mix was 1:2½; water was heated to 170 deg. F. and 4.75 gal. used per sack of cement; the mixing time was 5 min. and the temperature of the concrete when mixed was 100 deg. F.

After the concrete was placed, it was maintained at a temperature of at least 95 deg. F. and sprinkled with warm water for a period of three days. A 6x12-in. test specimen, mixed and cured in the same manner as previously stated, produced a compression strength of 3,170 lb. per sq.in. at three days. The temperature of the pile was maintained by a canvas inclosure in which were placed two coal stoves. The water which was heated for sprinkling the pile was heated on one of the stoves and escaping steam added to the humidity within the inclosure.

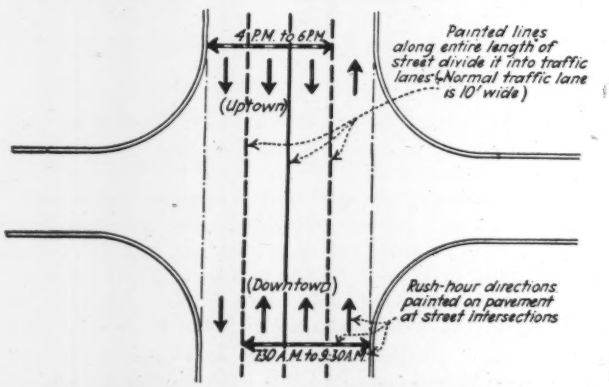
The pile was driven on the fourth day after it was made. The first 14 ft. of penetration, being through fine sand, was easily obtained by the water jet. As soon as the pile reached soft shale, the jet was no longer of any use and the flow of water immediately stopped. The pile was then driven 2.3 ft. through the shale, at which point it reached practical refusal, as determined by the *Engineering News* formula. No record was made of the total number of blows used in driving, but the pile successfully withstood 40 blows of a 2,500-lb. hammer dropped a distance of 10 ft. and 22 blows dropped a distance of 15 ft. The last 8 blows at 15 ft. produced a penetration of ⅜ in. The pile did not show the slightest evidence of shattering or abuse of any kind.

Reversing Street Traffic in Central Lanes Increases Capacity

By B. F. Affleck

President, Universal Portland Cement Co., Chicago, Ill.

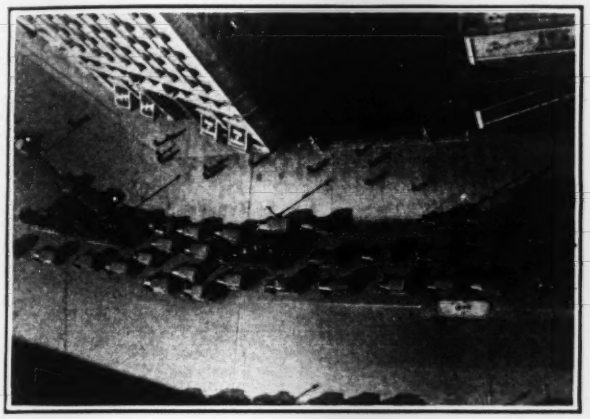
CITY officials, at a minimum of time and expense, are speeding up traffic, adding 50 per cent or more to street capacity and relieving congestion without any


4 P.M. to 6 P.M.
(Uptown)
Painted lines along entire length of street divide it into traffic lanes (Normal traffic lane is 10' wide)
(Downtown)
Rush-hour directions painted on pavement at street intersections
7:30 A.M. to 9:30 A.M.

MARKING DIAGRAM FOR RUSH-HOUR LANES

construction cost by the simple plan of reversing traffic on central lanes of traffic during rush-hours. The plan is in use in Cleveland and in a modified form in Pittsburgh, Indianapolis and elsewhere and serves as a relief to congestion until more fundamental measures can be adopted.

While increasing street widths is a basic remedy which must be employed eventually in solving the congestion problem in many cities, widening is a gradual process requiring time. Pending completion of such changes, immediate relief on many streets is being secured at small cost by use of "rush-hour traffic lanes."



UNEQUAL DENSITY OF TRAFFIC AT RUSH HOURS
Michigan Ave., Chicago, showing only half of street filled with cars at morning rush hours. This condition is reversed at evening. The right-hand side of the picture is north.

Capacity of certain streets in almost any city during the rush hours can be increased by 50 per cent or more with a minimum of cost by following the plan. For example, in Cleveland where on selected main thoroughfares having four traffic lanes and no street car tracks, three lanes are reserved for inbound traffic in the morning and three lanes for outbound traffic in the evening. Traffic is directed by dividing the street into traffic lanes and by rush-hour rules painted right on the pavement at important intersections as shown in the diagram. The same result has been accomplished in Indianapolis by movable safety islands and movable traffic signs.

This method lessens congestion and accelerates flow of traffic because it makes full use of the street capacity which now in many cases is only partly utilized. For example there are many streets where there is space for two traffic lanes in each direction but where there is often only one effective lane for travel in each direction because one lane on each side is used for parking. By prohibiting parking during rush hours only and by dividing the street into four lanes, there would be three lanes instead of only one for inbound traffic in the morning and three lanes instead of one for outbound traffic during the rush hours in the evening. In both morning and evening there would still be one lane for traffic in the opposite direction. While the parking prohibition inconveniences a few, it is only for a few hours and it accommodates thousands by providing more space for moving traffic when it is most needed therefor and least needed for parking.

Any street having space for three or more lanes will secure freer travel movement as a result of this plan. On a street from 28 to 32 ft. wide—that is, with space for three lanes—two lanes can be reserved for traffic in one direction and one lane for traffic in the opposite direction. On streets 36 ft. or more wide, the method will allow three lanes for traffic in one direction and one lane for traffic in the opposite direction during rush hours. On streets 56 or 60 ft. or more wide, four or even five lanes can be reserved for heavy travel during rush hours and one or two lanes for traffic in the opposite direction.

While such a method alone will be inadequate to accommodate the constantly growing motor traffic it will at least afford temporary relief in many cities until widening of such main thoroughfares may be accomplished.

Moving Earth Under Difficulties

IN THE construction of 2½ miles of state highway that constitute the approaches to the vehicular bridge across Carquinez Strait in California, it was necessary to move some 267,000 cu.yd. of earth. On the southern approach, where 207,000 cu.yd. were moved in a length of 1.8 miles, there is one cut 500 ft. long, 106 ft. deep and 100 ft. wide. Under the requirements of the contract, earth taken from the cut was spread in the fill in 1-ft. layers and then rolled with trucks, tractors and other heavy equipment so that the road could be put in use as quickly as possible with a minimum of settling or sliding. At one point the fill is 50 ft. deep.

Heavy-duty equipment used on the job included two 8,700-lb. tractors, two gasoline shovels and a number of heavy dump trucks. The tractors were used to move the shovels, to haul the loaded trucks out of the mud during wet weather, to pull the trucks back from the edge of the road where the spill from the shovels was dumped, and to haul scrapers and graders. The job was rushed from the start, three 8-hr. shifts being maintained part of the time. Due to the unusually rainy season, the ground was so softened as to make the trucking extremely difficult and several bad slides occurred. A typical view of tractors hauling trucks in the heavy mud on the south approach fill is shown in the accompanying illustration in the background of which is the central cantilever portion of the Carquinez bridge.

HEAVY DUTY EQUIPMENT FOR PLACING BRIDGE APPROACH FILL

The south approach is being constructed by Tieslau Bros., Berkeley, Calif., under contract with the California Highway Commission.

Pantograph for Reproducing Tunnel Sections

A LARGE pantograph constructed so that it can be revolved through 360 deg. and draw an exact cross-section to scale has been devised by D. W. Proebstel, Superintendent of Tests, Portland Electric Power Co., Portland, Ore.

The instrument was developed to measure tunnel cross-sections in order to check the volume of rock excated and determine the maximum and minimum rock breakage clearances from the finished tunnel.

PANTOGRAPH IN USE ON HYDRO TUNNEL

It is mounted on a transit tripod and provisions are made for leveling and centering. A small rubber-tired wheel is fastened on the end of the upper arm and this wheel is made to roll over the rough surface of the tunnel while an exact drawing is reproduced on the chart board.

The instrument was used in connection with the construction of a short tunnel at the Bull Run hydro-electric plant of the Portland Electric Power Co.

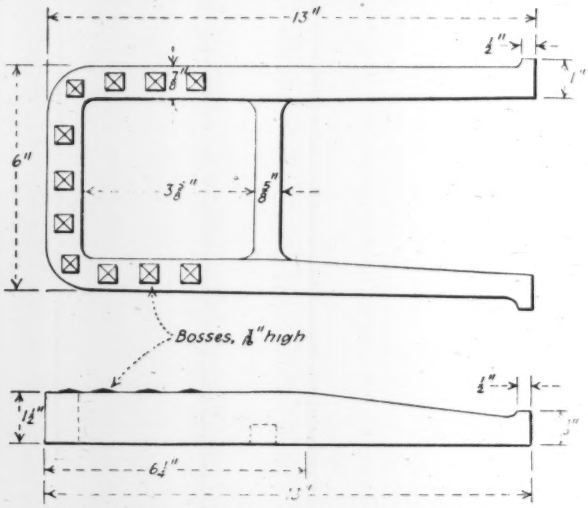
Special Cast-Iron Manhole Steps Eliminate Corrosion

THE complete corrosion of ordinary manhole steps in times past has caused a number of accidents and considerable expense in Oklahoma City. The city engineer recently has developed a cast-iron step of special design which is eliminating the corrosion expense and providing extra safe footing for the workmen.

The details of the step are shown in the illustration. The ball of the foot is prevented from slipping by the raised bosses, while the crossbrace provides a rest for the toe of the workman's foot. The steps are placed at every sixth course of brick and are inserted into the wall 6¾ in. The available step is 6 in. wide and 6¼ in. long. Each step weighs 10 lb.

From Job and Office

Hints That Cut Cost and Time



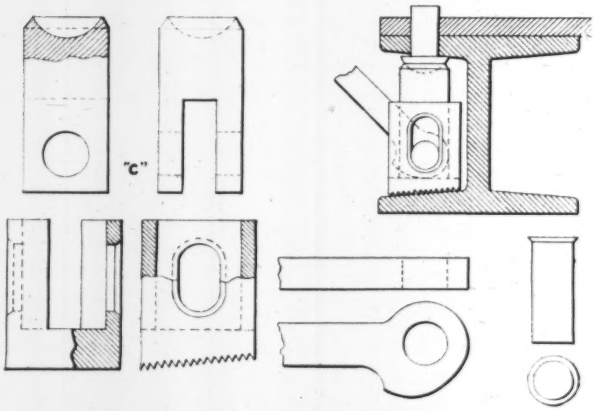
DETAILS OF SPECIAL CAST IRON MANHOLE STEPS

Manhole contractors can purchase the steps at any of the foundries in the city since these are all supplied with designs by the city engineer, B. M. Hart.

Riveting Dolly for H-Beams

By F. P. Terry
Belfast, Ireland

A HANDY tool for use when riveting H-beams in limited space is shown in the accompanying sketch. The tool itself consists of three parts with an operating handle. The part *C* can be made in various sizes and shapes to fit different sized beams and for use with



DETAILS OF DOLLY USED IN RIVETING H-BEAMS

different sized rivets. It is claimed that the heaviest rivets can be held against pneumatic hammers with this tool and the rivet head properly forced up against the angled face, avoiding the usual opening of the narrow side of the beam which is the case when an ordinary dolly is used for holding the rivets. The tool can also be used for other purposes such as a lifting jack or for forcing out drifts and bolts.

From Job and Office

For Contractor and Engineer

Fruit Jars Used to Construct Hourglass for Timing Concrete Mix

By Shirley C. Hulse
Consulting Engineer, Bedford, Pa.

By riveting the lids of two fruit jars together and punching a hole through them, a satisfactory timer, operating like an hourglass, was devised and used on a recent concreting job

MIXER TIMER MADE OF TWO FRUIT JARS

The amount of sand used was varied until it was found that it ran about 70 sec. before stopping. The man in charge of the mixer simply turned it over after the last of the dry material for each batch went into the mixer. When the sand stopped running, the mixer was dumped and the operation of turning the jar continued throughout the entire time the mixer was in operation.

The device proved popular with the men on account of its simplicity and created quite an interest. Attention was often called by the men to the fact that, as the sand became worn, additional sand should be added to maintain the proper time interval.

Foundation Experiences in Water-Bearing Soil

By Jacob Feld
Consulting Engineer, New York City

The unreliability of wash borings as the sole guide for the design of footings was well instanced by the conditions encountered in the building of a 10-story office building in White Plains, N. Y. The site is at practically the top of a long uniform 1 or 2 per cent slope, a half-mile from the Bronx River, the nearest open water course. The subsurface condition at the area of the proposed building, about 60x62 ft., was investigated by five wash borings located approximately at each corner and near the center of the plot. The borings showed no water levels to the depth from 13.4 to 23.5 ft. below the curb level.

The land was occupied by a three-story office building at the front connecting with a theater at the rear. While the plans for the new building were being made, the adjoining lot was being excavated, permitting an examination of an old brick bearing wall to be made. Although about 50 ft. in height and averaging 16 in. in thickness, the wall showed no signs of cracking or settlement even after the excavation adjoining it and only about 3 ft. away, had been carried on to a depth of 12 ft.

In carrying the excavation to the lot line, the old theater wall was found resting on a dry rubble footing wall extending only 3 ft. below grade on a dense hardpan subgrade. The excellent condition and stability of the wall agreed with the report of the borings and satisfied all who were concerned with the design of the new building that the foundations would give no trouble.

However, the excavation in the adjoining lot was carefully watched. The steam shovel was having difficulty making headway in the hardpan material. The banks were cut practically vertically and required no protection. This was the state of affairs, when, during the removal of the second layer, the steam shovel suddenly cut through a water-bearing fine sand at a depth of about 16 ft. A pit or trench was then dug to study the subgrade conditions. A thin layer of water-bearing sand was found immediately under the hardpan 2 or 3 in. in thickness. Below this again a dense, hard soil was encountered.

The same conditions were uncovered on the site of the new building. After consultation with the Building Department of the city of White Plains, it was decided to use the maximum bearing value of 4 tons for the design of footings. The combined live- and dead-loads on the column footings varied from 210 to 360 tons. The footings were designed for uniform soil pressure under dead-load only and a maximum soil pressure under full live-load of 4 tons per sq.ft.

Construction was made difficult because the footings were founded on the hard material below water level, although the finished cellar level was placed above the water line. The flow of water continued and was of such a large volume that pumping was not first made use of, although it was tried. Two methods for controlling the water were suggested, the method of driving well points around the perimeter of the lot to a level below subgrade and pumping from these to lower the groundwater level or temporarily freezing the water in the neighboring soil. While the first method was being carefully considered and the excavation was practically completed, the first frost of the winter arrived. An appreciable diminution of flow was noticed soon thereafter. Excavations for the five combined and ten simple footings were then made and with the aid of a small pit sump they were kept dry during the pouring of the concrete. Soon after the concrete was poured water filled the excavation, covering the footings entirely. After backfilling, the cellar floors were poured and waterproofed and no unusual leakage of water has been noticed.

Job and Office Notes

Protecting a Hazardous Private Road in a mountainous country by means of an all-welded steel pipe guard rail was recently accomplished by an oil company, according to *Oxyacetylene Tips*. The pipe rail was set on posts about 2½ ft. above the ground and consisted of used steel pipe of 2½-in. diameter. The posts were of a larger diameter and were slotted with a cutting blow pipe to provide a cradle for the rail. They were set in concrete and spaced about 5 ft. apart. Adjoining lengths of the pipe rail were butt-welded end to end and then welded to the posts. The rail was made to conform to the curvature of the road by bending while still hot from the welding or by means of a blowpipe. After completion, the entire rail was finished with a coat of weatherproof paint. Under actual conditions this guard rail was found to resist the heaviest types of trucks. Whenever the rail became bent, it was a small matter to restore its original appearance with a blowpipe, a sledge and a little paint. Use of the guard rail for conveying water can readily be made.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

San Francisco's Never-Used Garbage Incinerator

Sir—I am generally in agreement with the well considered editorials contained in your paper, which are usually very correct. Some statements, however, might lead to confusion, as, for instance, your reference to the San Francisco municipal incinerator, in your issue of March 3, 1927, p. 346.

Some 17 years ago a plan was developed for building four incinerators in as many parts of the city of San Francisco and a contract was let for two of them. Your subsequent discussion seems to leave an implication that the city was responsible for the failure of the contractor to deliver the article. Such, however, was not the case. The city took all possible precautions to get a valid set of specifications and to further this purpose employed as consulting engineer, at a fee of $5,000, Dr. Rudolph Hering, a man of distinguished reputation in sanitary science who was then regarded as an authority on the subject, to supervise the specifications. Plans and specifications were also supervised by an organization of business men known as the Chamber of Commerce, who fathered the incinerator idea and who were very enthusiastic over the enterprise and promised a successful solution of the problem.

In November, 1912, shortly after becoming city engineer, while the first unit was under construction, I examined a similar incinerator built at State Island by the same firm, which had the same sized furnaces and grate bars as our contemplated incinerators. I then told the contractors that the incinerator with grate space adequate for the hard-coal cinders of Staten Island would be absolutely inadequate for the wet garbage of San Francisco with about 50 per cent moisture. I stopped all work on the construction of the second incinerator until the first one was completed and could deliver the goods. Under dispassionate testing it was tried and failed and was condemned and has not since been used. It would have cost at least $3 a ton to burn garbage, with the low scale of wages 14 years ago, with this incinerator at 1,700 deg. temperature, at which it was supposed to work. The existing old Thackeray incinerator has since burned 1,200,000 tons of garbage at 700 deg. temperature at a cost of $1 per ton, and hence all the garbage has been piled on the Thackeray incinerator, at a saving to the city taxpayers of $2,400,000.

Permit me to repeat a statement I made to the Sanitary Engineering Section of the American Public Health Association, Oct. 3, 1924, which still holds good:

"The condition of the garbage disposal plants in our large cities is a disgrace and a reflection on the engineering profession, which has the matter in charge. Immense sums of money have been invested in fake incinerators, including expensive machinery, which is never used or fails to function. Witness the suspension of incinerators and garbage disposal plants in Seattle, Atlanta, San Francisco, Los Angeles and New York. Think of the crime of dumping garbage from New York in the ocean and polluting all the beaches on the coast up and down the shore line. I believe by collaboration from engineering talent, incinerator specifications could be drawn which would serve as a standard for the city engineers of our large cities."

San Francisco, Calif., March 11, 1927. M. M. O'SHAUGHNESSY, City Engineer.

[Although our correspondent officially ruled, some fifteen years ago, that the contract requirements for the San Francisco incinerator had not been met, the court held otherwise and the city paid the contract price. What it would have cost to run the plant is a matter of estimate, as the incinerator has stood idle all these years. The $1 a ton mentioned as the cost of operating the old Thackeray incinerator is merely what the private scavengers pay the Scavengers Association for putting the stuff through the plant. How much the householders contribute toward the cost of running the incinerator in the bills they pay to the private scavengers, no one knows. Moreover, however efficient the Thackeray incinerator was originally, it is now some thirty years old, is worked far above its rated capacity, only partly burns the stuff run through it, and a suit to close it as a nuisance is pending.

The closing statements of the letter are partly in error, and wholly misleading, the latter especially so as to putting the blame for suspensions of garbage and refuse disposal plants on engineers. The Atlanta incinerator, built at about the same time, and by the same contractor as the one at San Francisco, was not shut down. When Atlanta was compelled by the court to accept and pay for the incinerator, it put it in use, instead of letting it stand idle a dozen years or more as was done in San Francisco.—EDITOR.]

Tests on Steam Cured Concrete

Sir—In the publication of data covering the accelerated testing of concrete by means of steam curing in *Engineering News-Record*, Feb. 17, 1927, p. 282, it was intended that credit for working up the method, as set forth, be divided between J. T. Fullerton, F. Feeney, and the writer. Kindly give due publicity to the fact that credit should be equally divided.

In this connection you may be interested to note that Mr. Feeney has carried on a series of experiments supplementing our findings as published in that article. The new data will be ready for inspection in a few weeks. Mr. Feeney's recent work covers, among other items, the effect of the steam curing as applied to a range of mixes and the determination of the value of the time temperature unit which causes the rapid curing of the concrete. His address is Powell River, B. C.

Powell River, B. C., March 15, 1927. M. S. GEREND, of C. C. Moore & Co., Engineers.

Placement of Street Car Tracks

Sir—May I add a few comments to those of C. M. Durgin in *Engineering News-Record*, March 17, p. 460, with reference to locating street railway tracks adjacent to the street curb. With tracks so located, the opportunity for accidents due to collisions at cross streets is greatly increased as the car operator has less opportunity to view the cross traffic as it approaches the intersection, especially that coming from his right.

In winter operation it would not be practical to sweep the snow to the left of the track, or towards the vehicular roadway between tracks. It would be necessary to sweep it all towards the sidewalk, and that is where most of it would go. The objection to this is evident.

There is another serious objection from the city engineer's standpoint, namely, that such location brings the track in the sharpest part of the pavement grade and, because it is practically essential that the two rails remain at the same elevation, causes the greatest interference with the cross-sectional profile of the street pavement. The rails also interrupt the flow of water from the center of the street to the gutter. This condition is worse when the track is at the side than when located in the center of the street.

From the street railway point of view, it is always objectionable to have the track area form a part of the street area required to carry off storm water. It is apt to be much more difficult and expensive to maintain both track and pavement than would be the case with the track in the center. Then, too, there is the question of cross-overs having to cross all vehicular traffic in both directions—always a dangerous situation, and the difficulties encountered when it becomes necessary to construct branch-off curves leading into cross-streets.

In residential districts there would be the objection from the standpoint of the property owner, that it would not permit him to park his automobile in front of his own home, and in business districts there would be the added objection that trucks delivering merchandise to business establishments would seriously interfere with street railway traffic and would hinder the latter in giving the traveling public the service it demands.

By all means let the street railway tracks stay in the center of the street where they properly belong.

Newark, N. J., April 1, 1927. HOWARD H. GEORGE, Chairman, Committee on Way & Structures, A.E.R.E.A.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Summer School Planned for Engineering Teachers

Cornell and Wisconsin Tentatively Chosen for Two Three-Week S.P.E.E. Courses

The Society for the Promotion of Engineering Education announces that a summer school for engineering teachers will be established and the first sessions held in the summer of 1927. The Carnegie Corporation of New York has appropriated funds to operate the school for one year.

The establishment of the school is an outgrowth of the extensive investigation of engineering education which the society has been conducting for the past three years. The project was suggested by W. E. Wickenden, director of the society's investigation, as a result of his study of a similar school conducted in England. The project has been studied by the society's committee on teaching personnel, under the chairmanship of Dean Charles H. Warren of the Sheffield Scientific School of Yale University, and was formally recommended by that committee as a project which should be undertaken at as early a date as possible.

Two sessions of the school, each of approximately three weeks' duration, will be held during the first year. Cornell University and the University of Wisconsin have been tentatively selected as sites and negotiations opened with the authorities of those institutions. It is expected that tuition charges will be limited to a nominal registration fee and that costs of meals and rooms will be quite low.

Particular Subjects Stressed

The work of the school will center around the teaching of particular subjects of the engineering curriculum. The teaching of mechanics has been selected for the first sessions since that subject is fundamental to all branches of engineering. The work will be divided into three principal divisions: (a) The teaching of pure mechanics (analytic mechanics), (b) The teaching of the applications of mechanics in related fields, and (c) The exposition of methods of teaching in general.

Morning sessions will be devoted to lectures, demonstrations and laboratory exercises designed to illustrate methods of presenting particular divisions of the subject. The organization, content and scope of courses in mechanics will be discussed. Methods of teaching will be presented partly by precept and example and partly by lectures devoted to teaching methods in general. Afternoon sessions will be devoted to group discussions and to analyses of the work of the mornings. Evenings will be devoted to lectures on general topics relating to engineering education and to recreation. The teaching staff will be selected from among the foremost teachers of the engineering colleges and from among the faculties of teachers' colleges and departments of education of the universities.

For the first year, at least, the school will be conducted under the general supervision of the society's board of investigation and co-ordination, which board is charged with the duty of conducting the general investigation of engineering education. Immediate supervision will be in the hands of H. P. Hammond, associate director of investigation.

Flood Damages Spillway Channel at Gordon Valley Dam

About 500 ft. of spillway channel beginning 200 ft. below the spillway of Gordon Valley dam was carried out by flood waters on April 1. This dam is an earth fill 104 ft. high and was built two years ago as part of the municipal water project for Vallejo, Calif. The spillway is separate from the dam, is located in a ridge of hard shale and discharges into a channel with a 6-in. reinforced-concrete lining. The channel is on a 15 per cent grade and follows a ravine that makes a right-angle turn to get back into the main water course. The washout began when the lining at the bend in the channel was carried away by the flood. Hard shale underlying the channel prevented further erosion.

Engineering Fifty Years Ago

From *Engineering News*, April 14, 1877

THE success of the steam street cars in Philadelphia seems to be assured. During a single week the receipts of five horse-cars averaged $65, while those of five dummies averaged $100. The average expense of a horse car during that period was $62.86; that of a dummy $54.80.

Ontario Provincial Railway May Be Extended to Hudson Bay

The Ontario provincial government has under serious consideration the extension of the Temiskaming and Northern Ontario Ry. to James Bay on Hudson Bay from its present terminus at Pine Stump, 68 miles north of Cochrane, Ont. Premier Ferguson has intimated that construction is likely to start at an early date, perhaps this year. The proposed extension would open up new pulpwood areas and promote development of water powers as well as give access to mineral discoveries of probable importance.

Hudson River Flow Control Project Started

Bids Soon to be Opened on Work Preliminary to Sacandaga Reservoir Construction

As the first step in the construction of the Sacandaga reservoir, the Hudson River Regulating District is calling for bids on the construction of 25 miles of relocated highways in Saratoga County, N. Y. The Sacandaga reservoir is the first of a number of reservoirs proposed to be built by the Hudson River Regulating District to control the flow of the river. It is to be formed by the construction of a semi-hydraulic fill dam on the Sacandaga River at Conklingville, about 6 miles above its confluence with the Hudson. The reservoir will extend upstream from the dam about 27 miles and will have an area of 28,000 acres.

The preliminary work includes the relocation of highways to be flooded out by the reservoir, the construction of three highway bridges, the removal of about 3,500 graves, and clearing of the reservoir site. The board expects to do the clearing by force account and the remainder of the work by contract. It is not expected that construction of the dam will be undertaken until some time in the summer.

The Hudson River Regulating District is a public corporation having authority to construct and operate storage reservoirs, acquire real estate, issue securities, make assessments, and exercise the power of eminent domain in the acquisition of land. Its affairs are managed by a board of three men appointed by the governor. Its plans for the construction of the Sacandaga reservoir were approved by the Water Control Commission of the state of New York on May 12, 1924, but have been held up by litigation over the property of a railroad to be flooded out.

The board's first issue of bonds, amounting to $2,025,000, have just been sold. Edward H. Sargent, Albany, N. Y., is the chief engineer.

Rochester City Council Approves Plan for More Water

The plan for an additional water supply for Rochester, N. Y., recommended by H. P. Eddy, Allen Hazen and E. A. Fisher, as noted in *Engineering News-Record*, March 31, 1927, p. 542, has been approved by the city council, which has instructed the corporation counsel and C. Arthur Poole, city engineer, to apply to the State Water Supply Commission for approval of the plan. The report advised the raising of Honeoye Lake and the construction of a supply conduit to the Cobb's Hill distributing reservoir at an ultimate cost of $22,000,000 and an outlay for the immediate future of $12,000,000.

Short Section of Cascade Tunnel Holed Through

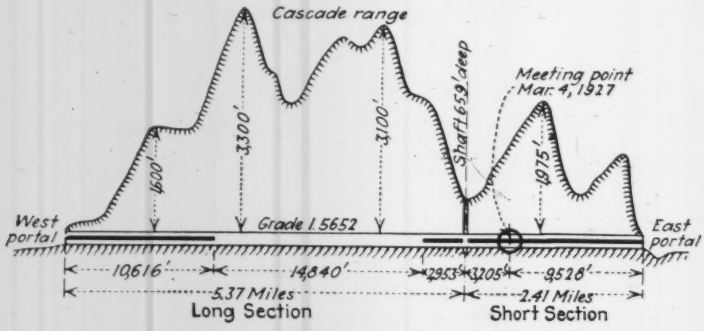
The 10x10-ft. center heading in the eastern or 2.41-mile section of the 8-mile Cascade tunnel was holed through on March 4, 3 months and 27 days ahead of schedule. This tunnel is being driven on the Great Northern R.R. and is divided by Mill Creek shaft into two sections. A description of the tunneling methods and report of the thrice broken world's record for speed in drifting was published in *Engineering News-Record*, Nov. 25, 1926, p. 858.

Work at the east portal began Jan. 1, 1926, and three 8-hr. shifts were worked continuously. From this heading the advance averaged 23 ft. per day, including the time required to get underground. For the first 3½ months power was not available for mucking machines and electric locomotives. During that time muck was loaded by hand into horsedrawn muck cars. After the power was available, the progress averaged 806 ft. per 31-day month with a maximum of 984 ft. per month. At Mill Creek work was begun Feb. 2, 1926, and the 659-ft. shaft, 8x24 ft. in cross-section was sunk and timbered in 174 days.

Surveys over the high peaks, carrying the center line from the east portal to the Mill Creek shaft, were made under unfavorable conditions in winter. The line was then offset over the tunnel shaft, which is 7 ft. south of the tunnel line, and was plumbed down the shaft by means of two 60-lb. plumb bobs suspended on piano wires. This gave a 19-ft. base line at the bottom of the shaft which was offset back to the tunnel center line. With this 19-ft. base line the surveys were carried 3,205 ft. east to the point where the headings met. The line closure error at the meeting of the two center headings was only 0.23 ft.

The faces of pioneer drifts from Mill Creek shaft headed west, and from west portal headed east, had been advanced a total of 13,569 ft. on March 4. Of this total, 10,616 ft. had been driven from west portal and 2,953 ft. from Mill Creek shaft. The remaining distance to be driven between these approaching headings was, on March 4, 14,840 ft., and it was then estimated that these headings would meet about Jan. 1, 1928.

The Cascade tunnel is being driven under contract held by A. Guthrie & Co., Inc.



PROGRESS OF WORK ON CASCADE TUNNEL

Strikes Against "Unfair" Cut Stone Declared Illegal

Interstate Character of Maker-Union Controversy Basis of Decision By U. S. Supreme Court

Strikes called by labor organizations to prevent the use after passage in interstate commerce of commodities produced by corporations or individuals with which the labor organizations are engaged in controversy violate the anti-trust act and legal relief may be sought by injunction by Section 16 of the Clayton Act, the United States Supreme Court held April 11 by a divided decision.

Through an opinion by Justice Sutherland, the majority of the Court reversed the Circuit Court of Appeals for the seventh circuit which had sustained the Federal District Court for Indiana in dismissing for want of equity an injunction appeal filed by the Bedford Cut Stone Co. and 23 other corporations engaged in quarrying or fabricating limestone against the Journeymen Stone Cutters' Association of North America and various locals of that organization and various officers of the union. Justice Brandeis filed a vigorous dissenting opinion. Justices Stone and Sanford filed separate opinions concurring with the majority but on different grounds.

In the majority decision it is declared that the strikes, ordered and carried out with the sole object of preventing the use and installation of the products of the complaining corporations in other states, necessarily threatened to destroy or narrow their interstate trade by taking customers from them. The court held that it is beside the point that the labor organizations in general purpose and in and of themselves are lawful and that the ultimate result aimed at may not have been illegal in itself. It held that the means adopted by the labor organizations are unlawful and that in such a case the innocent general character of the organizations or the lawfulness of the ultimate end sought fail as a justification.

In its fight against the stone producers, who were conducting an open shop, the union issued a notice to all locals and members directing them to refuse to work on "unfair" stone or stone which had been handled by non-union labor, and this rule was adhered to against the product of the corporations in a number of cities in various states.

State Power Conference Held at University of Iowa

On Mar. 30 and 31 a state-wide power conference was held at the University of Iowa, Iowa City, under the chairmanship of Dean C. C. Williams of the engineering college of the university. It was devoted to discussion of power resources, and the methods and possibilities of their utilization.

Reviewing the present power situation in Iowa, Joe Carmichael, director of Public Utility Information, gave a general summary of power production data and Prof. F. A. Nagler discussed water power development, showing that while the total water power generated had increased the number of plants had decreased owing to the discontinuance of small installations. H. R. Summerhayes, of the General Electric Co., described recent technical developments in power transmission.

Dean Williams outlined the fundamentals of power rates, and Prof. A. H. Ford pointed out the possibilities for interconnecting in Iowa. John A. Reed, of the Iowa Electric Co., and others who discussed the latter paper expressed the opinion that smaller systems rather than superpower zones are best adapted to Iowa conditions.

Utilization of Iowa coal formed the theme for one half day. T. A. Marsh, of the Combustion Engineering Corp., showed both by laboratory test data and plant operating results that Iowa coal can be used economically if the combustion chamber is properly designed. E. F. Bulmahn, of the Iowa Southern Utilities, which operates mines as well as power stations, stated that economies should be effected in mining in order to make Iowa coal compete with Illinois and Kentucky coals.

Dean G. F. Kay, state geologist, gave a vivid exhibit of the mineral resources of the state that could be developed through the use of power, following which W. J. Maytham, of the Northern States Portland Cement Co., presented the experiences of his company in the use of power in manufacturing cement. Papers by R. J. Eustace and Arthur Schwerin, further set forth the opportunities and advantages of using power in manufacturing in Iowa.

Newark Buys Morris Canal

That part of the old Morris canal lying within the city limits, 6.81 miles in length, is to be acquired by the city of Newark for $425,000. The city is to pay the State Board of Conservation and Development that sum in cash within 60 days and will issue, for that expense, temporary loan bonds. Under the agreement the purchase price will include the canal bed and all other properties owned by the Morris Canal & Banking Co., former operators of the canal. Such properties include tow paths, locks and other pieces of land held by the company within the city limits. The executive committee of the state board is made up of the directors of the Morris Canal & Banking Co.

The old Morris canal will probably be used by the Public Service Commission for subway and depressed track street railways.

Admiral Harris, on Retired List, Enters Consulting Work

Under the authority conferred on him by a Special Act of Congress of March 4, 1925, President Coolidge, through Secretary of the Navy Wilbur, has authorized the placing of Rear Admiral Frederick Robert Harris, Civil Engineer Corps, on the retired list. This special legislation was in appreciation of the services rendered by Admiral Harris during the World War and during prior years as chief of the Bureau of Yards and Docks and in other capacities in the Civil Engineer Corps services.

He has completed twenty-four years of service, the first half of which was in the rank of Lieutenant and Lieutenant-Commander, and the last half in the highest permanent rank in the Navy. He has never served in the rank of commander or captain which grades he jumped, having been selected by President Wilson during the period of preparedness before the war for advancement from lieutenant-commander to temporary rear admiral as chief of the Bureau of Yards and Docks, and directly before war was declared, for the permanent rank of rear admiral.

Admiral Harris has entered private consulting practice at 551 Fifth Ave., New York City. His work will be of a general engineering nature, including foundations, waterfront improvements, dry docks, piers, bridges, steel and reinforced-concrete structures, reports, estimates and construction management.

C. E. Smith Appointed to Study N. Y. Transit Situation

Charles Edward Smith, a St. Louis consulting engineer, has been retained by Comptroller Berry of New York City to make a survey of the city rapid-transit situation. The appointment of Mr. Smith is in line with the intent of the Walker administration in New York City to determine if that administration is pursuing the proper transit policy both from the physical and financial standpoint.

Mr. Smith was appointed from a list of five engineers submitted to Comptroller Berry at his request by the American Society of Civil Engineers. Mr. Smith has spent a great deal of his professional life so far in railway and transportation work. He is a graduate of the Massachusetts Institute of Technology. After short periods of service as assistant city engineer of Putnam and Willimantic, Conn., in the bridge designing department of the New York, New Haven & Hartford R.R., structural steel draftsman of the Bureau of Yards & Docks in Washington, assistant engineer on bridge erection and inspection work with the Lake Shore & Michigan Central Ry., and as technical editor of the structural materials division of the U. S. Geological Survey, Mr. Smith in 1907 entered service of the Missouri Pacific Ry. He was first assistant engineer in the maintenance-of-way department, but from September, 1909 to July 1913 was bridge engineer, being in that latter year appointed assistant chief engineer. In 1915 he opened a consulting office in St. Louis, where he has since been.

New York May Use Ward's Island for Sewage-Works

Governor Smith has signed a legislative act surrendering to New York City the northern part of Ward's Island and authorizing the city to use the land for sewage-works and to build a sewer westerly therefrom beneath the Harlem River to Manhattan Borough. The island was leased by the city to the state for institutional purposes years ago. Extensive sewage-works on this site were recommended in a report made to the Board of Estimate some months ago by Arthur S. Tuttle, chief engineer of the board. Besides the tunnel under the river a short length of intercepting sewer will be required. The cost of the project is estimated at $40,000,000 to $50,000,000.

Active Bidding on West Tower Pier of Fort Lee Bridge

Eleven contractors submitted 13 bids for the New Jersey tower pier of the Fort Lee bridge across the Hudson River. Bids were opened by the Port of New York Authority on April 11. Two methods of construction were proposed in the call for bids, open cofferdam and pneumatic caisson. Two contractors bid on both methods, their figures being respectively $350,000 and $825,000 higher for the pneumatic method than for the cofferdam method.

The bridge is to be a suspension highway bridge of 3,500-ft. main span and 650-ft. side spans. The New York tower will be located in exposed rock just above the shore line at Fort Washington Point, while the New Jersey tower location is between the shore and the harbor line, at a point where the depth to rock is about 75 ft. Rock surface slopes toward the river. The proposed tower base is to consist of two rectangular piers each 89x100 ft., set 67 ft. apart in the clear; at 15 ft. below water the pier masonry reduces to 76x87 ft., continuin · to the base of the tower itself at 15 ft. above water. Each of the two piers is to be built in a single cofferdam, but for the pneumatic method the plans show three caissons for each pier (6 caissons for the entire tower base). Cofferdam construction is to be done by excavation inside a driven or built cofferdam, the detail construction being left to the contractor. Rock is to be exposed and leveled off in either method. The bids follow:

	OPEN COFFERDAM METHOD
Silas B. Mason, Inc.	$1,160,200
Ground Construction Corp.	1,282,870
Triest Contg. Corp.	1,881,000
Underpinning & Foundation Co.	1,897,450
The Foundation Company	1,985,210
Cornell Contg. Company	2,293,200
	PNEUMATIC CAISSON METHOD
Arthur McMullen Co.	$1,434,150
Arundel Corp.	1,597,510
Frederick Snare Corp.	1,829,240
Subsurface Corp.	2,207,500
W. H. Gahagan	2,237,100
The Foundation Company	2,325,150
Underpinning & Foundation Co.	2,723,350

San Francisco to Lease Garbage Plant—Sea Dumping Planned

The San Francisco board of supervisors on April 4 voted to lease to the City Garbage Removal Co. the old Thackeray destructor in which San Francisco's garbage has been burned for many years. This destructor is the property of the city and in recent years has been operated, rent free, by the Scavengers' Protective Union, an organization of private scavengers. The union has been charging its members $1 per ton for all garbage delivered to the plant and this rate is to be continued by the City Garbage Removal Co. which has offered to pay the city $137 per day rental for the privilege of operating the plant at the $1 per ton rate. The scavengers, declaring that they have been unable to make any profit on plant operation even without rent, have expressed a willingness to continue delivery to the new plant operators.

Meantime arguments have been heard in an injunction suit against the city that asks the shutting down of the incinerator as a public nuisance. No court order has been handed down in the case as yet, perhaps because the city claims to be moving with all diligence toward putting into effect a plan for garbage disposal at sea.

In preparation for ocean disposal, plans have been drawn for the construction of a loading wharf in the Islais Creek district to be equipped to handle garbage at the rate of 15,000 tons per month. Under an arrangement with the California Board of Harbor Commissioners the city will pay a toll of 5c. per ton for each ton of garbage loaded at the wharf which will be on state land. The plans include a 110 x 240-ft. loading wharf to cost $54,000 and an approach pier, 24 ft. wide by 900 ft. long, to cost $36,000. The combined structure with equipment for handling the garbage is estimated to cost $138,477.

Figuring interest at 5 per cent and a 10-year amortization period, the fixed charges on a 15,000-ton basis are estimated to amount to $22,000 per month or 12.2c. per ton. Operating charges on the same basis, including labor, power, etc., are estimated to total $45,000 per month, or 25c. per ton. No contract with steamship or towboat company for taking the garbage to sea had been made up to April 8.

Baltimore to Vote on $47,500,000 in Bonds May 3

Baltimore is to vote on loans totaling $47,500,000 at the municipal election to be held on May 3. The General Assembly, which has been in session at Annapolis, has passed bills giving the city authority to submit the loans to the voters and all the measures have been signed by Gov. Albert C. Ritchie. The amount is made up of $10,000,000 for school construction, $10,000,000 for sewers and storm-water drains, $10,000,000 for water supply, $8,000,000 for streets and bridges, $4,000,000 for buildings, $3,000,000 for a new library building, $1,500,000 to establish an airport and $1,000,000 for conduits.

Washington Notes

THE $200,000 allocated for Cove Creek on the Tennessee is to be expended by the Chief of Engineers for the determination of foundation conditions at Cove Creek and for a special study of the principal storage sites on the Tennessee River from its mouth to Knoxville. An estimate will be made of the cost of the Cove Creek project and a study made of the economic features of the development.

This work is being undertaken at the request of the Military Affairs Committee of the House of Representatives for the purpose of determining the cost of the development and to get more definite information as to the relationship of the project to Muscle Shoals and to other upper Tennessee water-power sites.

BIDS for twenty-five additional barges for use on the upper Mississippi River are to be requested by the Inland Waterways Corporation. Fifteen barges for the service now are under construction. The proposal to construct the new barges was approved April 8 by the advisory committee of the corporation.

In view of successful experiments with powdered coal on the lower Mississippi, the board decided to halt construction plans on towboats because of the probability that structural changes will facilitate the use of fuel in that form. A saving of 50 per cent in fuel cost is indicated by the experiments, the board was informed.

The board declined to authorize more equipment for use between New Orleans and St. Louis. More up-river cargo is being offered than can be handled with present equipment but the board insists on limiting equipment to that for which return cargo can be furnished.

ANOTHER case of municipal ownership versus private development has arisen on the Kalamazoo River at Allegan, Mich. The city of Allegan is seeking rights which conflict with an application filed with the Federal Power Commission by the Fargo Engineering Co. Under the plans submitted to the commission it would appear that the Fargo Engineering Co. proposes a fuller use of the water than the municipality, but the costs of the respective developments are not known as yet.

ENGINEERS throughout the country are being asked by American Engineering Council to acquaint the members of the Seventieth Congress, which will convene Dec. 6, with the provisions of the perfected Public Works Department bill. This bill, which was drafted by the committee headed by E. O. Griffenhagen of Chicago, was not ready for introduction until near the end of the last session so that no opportunity was offered to do more than introduce the bill.

Members of Congress are much more likely to give sympathetic consideration to legislative proposals when they are brought before them by their own constituents. Since many of the legislators now are in their home districts, local engineers will endeavor to win their support for the simplified bill, which provides for the change of the name of the Interior Department to that of the "Department of Public Works and Domain."

Full details of the bill as presented to Congress were given in *Engineering News-Record*, Jan. 27, 1927, p. 154.

Denver & Rio Grande Ry. Starts Improvement Program

The Denver & Rio Grande Western Ry. Co. has an $8,000,000 improvement program well under way. The program involves extensive revision of trackage, rectification of alignment, reduction of grades and curves, laying of heavier rails, larger locomotives, new passenger and freight equipment, and modern water-treating plants.

The first contract for grade and line revision was recently awarded to Platt Rogers, Inc., of Pueblo, covering 25 miles between Canon City and Salida, involving an expenditure between $500,000 and $600,000.

Moffat Tunnel Progress

Up to April 1 the progress record of the Moffat Tunnel was as given below. The pioneer or water tunnel was holed through on Feb. 18. On April 1, there remained 790 ft. of headings to be driven for the main tunnel and 4,401 ft. of tunnel to be enlarged to full section. Three of the Lewis girders or cantilever needle-bars (*Engineering News-Record*, June 11, 1925, p. 970) are in operation and a fourth is being built, so that the remaining soft ground may be excavated and lined expeditiously.

	From East Portal Ft.	From West Portal Ft.	Total Ft.	Per Cent Finished
Pioneer tunnel..	.....	.....	.....	100.0
Main headings...	18,022	13,441	31,463	97.6
Full section.....	15,640	12,212	27,852	86.5

Acheson Made Chief Engineer of N. Y. Public Works

William M. Acheson, city engineer of Syracuse, N. Y., has been appointed chief of the Engineering Division of the Department of Public Works of New York State. This position, according to the recently reorganized plan, includes all the duties formerly within the province of the elective state engineer. Mr. Acheson's appointment is the result of a civil service examination which he passed first on the list.

Mr. Acheson is a graduate of Rensselaer Polytechnic Institute and Union University. His early professional life was spent in various capacities in the Panama Canal Zone, which place he left in 1910 to become supervising engineer of the County Construction Co., of New York. In October, 1913, he was appointed dvision engineer of the New York State Highway Department, a position he held until early in 1917, when he was made chief engineer of the Crescent Portland Cement Co., of Wampum, Pa.

Personal Notes

JACOB LABISHINER has been made senior assistant in the office of the city engineer of Syracuse, N. Y. For the past three years Mr. Labishiner represented an asphalt paving company in eastern New York, following a term as city engineer of Amsterdam, N. Y.

L. A. JENNY, for the past three years locating and valuation engineer of the Fonda, Johnstown & Gloversville R.R., has established himself as a consulting engineer, at Dumont, N. J., for practice, in connection with steam and electric railroads, on location, design and construction, terminals, and investigations and valuation. Before the War, Mr. Jenny served eleven years with the New York Central R.R., in different periods as assistant engineer, in charge of permanent trackwork in the Grand Central terminal, in Buffalo on improvements, and in other terminal and waterfront developments. During the World War he was at first captain of engineers and then major in the Transportation Corps, and later in charge of railroad reconstruction in the Verdun region. Returning to America, Mr. Jenny was resident engineer on dry dock construction for the U. S. Shipping Board and later assistant engineer in charge of the Cunard marine terminal at Weehawken, N. J. Later, under Col. F. A. Molitor, he made a study and report on unification of railroad terminals at Chicago.

RICHARD T. MCKAY, a structural engineer, formerly of Chicago, is now associated with Homer Harper, architect, at Benton Harbor, Mich.; together they are conducting a general engineering and architectural practice.

CHARLES M. COFF was recently made engineer of construction on the Starved Rock lock and dam project near Ottawa, Ill., for the Woods Brothers Construction Co. Mr. Coff was state bridge engineer of Nebraska from 1921 until 1926.

WILLIAM G. SLOAN, state highway engineer of New Jersey, has been reappointed for another four-year term. EDWARD E. REED has been given another term as assistant engineer.

CLARENCE W. PIERCE has been appointed superintendent and resident engineer on the construction of a hydroelectric plant near Hickory, N. C., for the Western Carolina Power Co., an affiliate of the Southern Power Co. and Duke Power Co. Mr. Pierce was recently employed as resident engineer on the construction of a heating plant, pipe tunnel, concrete bridges and railroad underpass for Duke University, Durham, N. C.

WILLIAM H. BAKER and C. G. SPENCER announce the formation of the firm of Baker & Spencer, Inc., with offices at 117 Liberty St., New York City, for the general practice of engineering and construction. Mr. Baker has just resigned as vice-president of the North

American Cement Corporation, in order to form this new company. In past years, he acted for ten years in managerial capacities for the Atlas Portland Cement Co., two years as vice-president and general manager of the Hardinge Co., three years as president of the Quigley Fuel Systems, and two years as president of the Acme Cement Corporation. Mr. Spencer has been engaged in the design, construction and operation of power plants for industrial and public utilities companies, railway electrification, plant construction, and cement manufacture, at different times with Westinghouse, Church, Kerr & Co., the Toronto Power Co., and McClellan & Junkersfeld.

NICHOLAS V. BACK has resigned as assistant city engineer of New Castle, Pa., to accept a position with the American Bridge Co. at its Pencoyd, Pa., plant, on structural detailing. Mr. Back was formerly employed in the Philadelphia and Allentown districts of the Pennsylvania Highway Department.

DON C. ESTES, who recently joined the St. Louis office staff of the Portland Cement Association, is a graduate of Purdue University and not of Cornell University as stated in these pages March 24.

J. SELSEMEYER has been reappointed for a three-year term as chairman of the Montgomery County, Tenn., Highway Commission. Mr. Selsemeyer has served as resident engineer, office engineer, and assistant division engineer for the Tennessee State Department of Highways.

E. H. HATCH, for seven years resident construction engineer on power projects of the Pacific Gas & Electric Co., has resigned to accept a position with the British Electric Railway Co., Ltd., Vancouver, B. C., as engineer on new development work.

G. D. O'CONNOR, who has been assistant to T. S. Scott, city manager and engineer of Niagara Falls, Ont., has joined the engineering staff of Miller & Sons at Niagara Falls.

LANDFORD T. ADEN, who has been employed with the Sydney E. Junkins Co. on harbor construction work at Vancouver, B. C., has opened an office in the Rogers Building at Vancouver for consulting engineering practice in steel and concrete construction and subaqueous work.

H. HOWARD KOB, civil engineer, Denver, Colo., has been appointed civil engineer for the Liberian government. Mr. Kob will have his headquarters at Monrovia in the Liberian jungles. He is a graduate of Colorado Agricultural College.

MARCEL MAZEAU has been named city engineer of South Jacksonville, Florida, succeeding J. L. Crary, who resigned. Mr. Mazeau has been for several years in the Jacksonville engineering department as assistant engineer in charge of sewers and drains. Before going to Florida, he was successively in the city engineering department of Mount Vernon, N. Y., superintendent on concrete and forms in construction of the Hell Gate bridge, on sewer work in Brooklyn, and in railroad service on concrete construction and valuation. Mr. Mazeau is a civil engineering graduate of Columbia University.

CUTHBERT E. REEVES, Buffalo, N. Y., announces his withdrawal from the firm of Ellsworth, Barrows & Reeves, to open a separate office in the Liberty Bank Building, Buffalo, where he will continue engineering practice, valuation investigations, reports and testimony.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Asheville, N. C., April 20-22, 1927.

NATIONAL DRAINAGE CONGRESS, Chicago, Ill.; Annual Meeting, Amarillo, Tex., April 21-23, 1927.

BUILDING OFFICIALS CONFERENCE, Portland, Ore.; Annual Meeting, Chicago, April 26-29.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York City, April 27-29.

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Annual Meeting, Washington, D. C., May 9-11, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

SOCIETY OF INDUSTRIAL ENGINEERS, Chicago, Ill.; Annual Meeting, Chicago, Ill., May 24-27, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

A Columbus, Ohio, Chapter of the Associated General Contractors has been completed by the election of E. H. McGrath of D. W. McGrath & Sons, president; J. W. Heckart, vice-president; R. H. Dowling of the Middle States Construction Co., secretary; and H. Elford of E. Elford & Son, treasurer. C. E. Palmer of R. H. Evans & Co., was named group chairman, representing the general contractors. E. P. Martin has been named executive secretary and headquarters will be at 707 Park St. South.

The American Railway Bridge & Building Association announces the following subjects for committee reports to be presented at its annual meeting next fall: (1) Recent developments in concrete construction; (2) handling foundation excavation; (3) materials for floors of highway bridges; (4) applying and repairing waterproofing on concrete structures; (5) uniform distribution of bridge and building work throughout the year; (6) railway stock yards; (7) protection of men doing work under traffic (8) operation and maintenance railway of water treating plants.

The Rochester, N. Y., Engineering Society will hold its annual dinner April 23. Roy G. Finch, former state engineer of New York, will speak on "New York State Waterways and Water Power."

The Western Society of Engineers has nominated the following for 1927-1928 officers: President, Rufus W. Putnam, chief engineer, Harbor Plan Commission, Chicago; vice-presidents, John A. Garcia, consulting engineer; W. S. Monroe, of Sargent & Lundy Co.; D. J. Brumley, chief engineer of Chicago Terminal Improvements, Illinois Central R.R.; and treasurer, George W. Hand, assistant to president, Chicago & Northwestern Ry. trustee.

The Boston Society of Engineers at its April meeting (tentative date April 27) will be addressed by Dr. George H. de Thierry, a noted European engineer and professor of harbor and canal engineering at the University of Charlottenburg, Germany, who will talk on the application of laboratory research to river, canal and harbor works.

The National Conference on City Planning will hold its nineteenth meeting at Washington, D. C., May 9 to 11. The presidential address by John Nolen, Cambridge, Mass., will be entitled "Twenty Years of Planning in the United States." A large part of the time of the conference will be given to various phases of regional planning, opening with an address on "Public Services which Require Regional Planning and Control" by Nicholas S. Hill, Jr., consulting engineer, New York City, and president of the Hackensack Water Co. of New Jersey. There will be roundtable discussions on various subjects with zoning as a topic at several. The leader on zoning is Edward M. Bassett, New York City.

Obituary

CHARLES L. PARMELEE, consulting engineer, New York City, died April 4 at his home in West Orange, N. J., aged 43 years. His office was in the Woolworth Building, New York City. His work had been chiefly connected with water-works, filtration systems, reservoirs, dams for water supply, tunnels, and power plants. He was connected with the investigations regarding filtration at Louisville, Ky., Pittsburgh, Pa., Toledo and Cincinnati, Ohio, and other cities, also connected with the construction of the Yuma dam, the water-works dam at Keene, N. H., and many other works. At various times he worked with G. W. Fuller, J. G. White & Co. and the T. A. Gillespie Co.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Reinforcing Steel Institute Holds Third Annual Meeting

The third annual meeting of the Concrete Reinforcing Steel Institute was held at White Sulphur Springs, W. Va., March 21-23. George E. Routh, Jr., vice-president, Kalman Steel Co., Chicago, was elected president of the institute; C. Louis Meyer, president, Concrete Engineering Co., Omaha, vice-president; and Hugh J. Baker, president, Hugh J. Baker & Co., Indianapolis, treasurer. M. A. Beeman was re-elected secretary of the institute. W. H. Pouch, president, Concrete Steel Co., New York, and D. B. Knowlton, general manager, Dudley Bar Co., Birmingham, were elected directors succeeding Louis Aronstam of Atlanta and P. J. Igoe of Newark, N. J., whose terms expired. R. W. Johnson, formerly with the Portland Cement Association, was appointed promotion engineer of the institute.

In the business session, the committee on foreign steel anounced that in the future every member of the institute would be pledged to enlist the support of members of Congress to cause foreign-made reinforcing bars to be marked with the country of origin. The rail steel committee reported that a more intimate relationship had been established with the rail steel interests through a series of conferences held during the past few months. The grade of steel committee reported on the recent adoption of the single grade of billet stock reinforcing steel; its report was adopted by the institute. As reported in *Engineering News-Record*, March 24, p. 506, the grade selected was the intermediate grade of the A.S.T.M.

In his address, W. H. Pouch, retiring president, stated that the institute now has 49 members operating 98 warehouses in 42 cities.

Suggestions for Preparing Prize Papers on Arc Welding

For writing papers for the arc welding prizes offered by the Lincoln Electric Co., Cleveland, and explained in *Engineering News-Record*, March 3, p. 375, the donors make the following suggestions. All applications of arc welding can be divided roughly into three classes:

First: Those where welding replaces riveting.

Second: Those where welding replaces castings.

Third: Those where special designs possible with arc welding only will replace present day designs at a saving either in cost of production or in resultant work.

Where arc welding will replace riveting, the problems are the origination of designs which will use arc welding to the best advantage and the most economically, and whereby the erection of the parts may be done at the lowest possible cost. This is particularly true in the erection of fabricated steel in buildings, bridges, and boats. Also, the fabrication of girders and columns so as to produce the maximum resistance to failure with the minimum cost, is something on which a tremendous amount of work can be done with profit.

For the second classification it is suggested that in Diesel engines, automobile engines, radiators, cast iron pipe, boilers, bases for machinery, and the ordinary work of the job foundry, castings can be replaced by arc welding. The actual designing of the substitution, in all these cases, is a problem of great importance.

Under the third classification comes the large division of "building-up" operations, such as is often necessary on switch points, cross overs, railroad rails, and other wearing equipment.

Other subjects which perhaps do not come directly under the classifications mentioned above, are a method of welded joint inspections so as to determine its strength without test and the making of field joints in pipe lines. There is also the very important problem of getting the facts regarding the advantages of arc welding into the minds of engineers and the general public. The American Society of Mechanical Engineers is sponsoring the plan and has the custody of the $17,500 in prizes that are offered. Calvin Rice, 29 West 39th St., New York City is secretary of the society.

Joint Quantity Estimates to Be Made by Fabricators' Association

A quantity estimating department has been organized by the Structural Steel Board of Trade, an organization of the steel fabricators of New York City and vicinity, according to an announcement just issued by Charles L. Eidlitz, chairman. The new practice is expected to reduce the liability of mistakes, in the interest of both bidders and owners. Franklin H. Branin has been retained as engineer of the estimating department.

Business Notes

W. W. PETRY, welding engineer, for several years in charge of welding for the American Rolling Mills Co. and consultant for the clients of that company, has formed, together with W. R. Crane and C. W. Shartle, The United Welding Co., with offices at Middletown, Ohio. This company has purchased the assets of the C. C. Fouts Co. and is ready for contracts for welding, welded sheet-metal products and welding engineering service. Mr. Crane was for many years in the sales division of the American Rolling Mills Co., and Mr. Shartle has been connected with the Shartle Brothers Machine Shop, of Middletown.

CHAIN BELT CO., Milwaukee, announces the appointment of the Lone Star Road Machinery Co. as its distributor in Texas. The company is located at 2003 South Akard St., Dallas, Texas.

DAYTON-DOWD CO., Quincy, Ill., manufacturers of centrifugal pumps, announces the opening of a new sales office in charge of the Murphey Equipment Co., Charlotte, N. C.

THE COPPER AND BRASS RESEARCH ASSOCIATION announces the appointment of H. A. Call, of New York, as mid-western representative. Mr. Call will establish a branch office of the association in St. Louis. These arrangements have been made as a result of the increased building activity in the Middle West. The St. Louis office will co-operate with the trade in the Mississippi Valley in connection with the use of copper, brass and bronze for building construction and industrial purposes.

EARLE GEAR & MACHINE CO. has appointed William H. Allen, 110 State St., Boston, Mass., as New England manager, to take care of all matters pertaining to Earle products originating in the New England territory.

EDWARDS & CO. has opened its own branch office at 176 Federal St., Boston, Mass., under the management of J. T. Gorman. On March 1 it also opened its own office at 626 Land Title Bldg., Philadelphia, Pa., under the management of R. H. Andrews. Both of these offices will be fully equipped with samples and information on complete electric signaling devices.

E. S. BLACK has rejoined the American Manganese Steel Co., with his headquarters at Chicago Heights, Illinois. His duties are those of consulting engineer, both mechanical and sales. Mr. Black's experience in the steel industry generally and his intimate contact with the manganese steel castings business in all its phases, over many years, peculiarly fit him to serve the users of manganese steel castings. A. H. EXTON has also rejoined the Amsco organization, in the capacity of chief engineer. Mr. Exton is an authority in the design and manufacture of manganese steel castings.

O. B. KELLER, who was formerly associated with the Keuffel & Esser Co. for many years, is now connected with the sales department of the New York Blue Print Paper Co.

WHITE CO., Cleveland, Ohio, has opened a new addition to its engineering building, which almost doubles the floor space given to engineering and research activities in the production of White trucks and buses. Main floor

and basement space in the new building totals 48,000 sq.ft. Total space now given to engineering is 102,400 sq.ft.

A. P. SINCLAIR, until recently with the Missouri Paint & Varnish Co., is now associated with Hill, Hubbell & Co., manufacturers of paints and varnishes, San Francisco, Calif. The latter company has obtained the right to manufacture and sell L & S Portland Cement Paint and Mr. Sinclair will devote his time to the distribution of this product, as well as the company's line of lighthouse paints, varnishes and enamels.

W. S. HOVEY has been elected president of Fairbanks-Morse & Co., Chicago, the former president C. H. Morse becoming chairman of the board. Mr. Hovey started with the company as assistant superintendent of the Sheffield Car Co., affiliated with Fairbanks-Morse, in 1902. Since 1924 he has been general manager of Fairbanks-Morse & Co. and this position he will still retain.

PITTSBURGH TESTING LABORATORY announces the removal of its offices from 50 Church St. and its laboratory from 35 Sixth Ave., New York City to its new laboratory and offices located at 72 Washington St., New York City.

THEW SHOVEL CO., Lorain, Ohio, announces the appointment of Paul Malenchini as export manager. Mr. Malenchini's headquarters will be at the general office at Lorain.

KOEHRING CO., Milwaukee, Wis., announces the appointment of K. H. Talbot as director of sales in charge of domestic and foreign sales. Mr. Talbot resigned as manager of cement sales of the Cowham Engineering Co. of Chicago to accept this appointment.

WEHR CO., Milwaukee, Wis., manufacturer of Fordson equipment, has opened a factory branch in Chicago at 2343 South La Salle St. This branch will serve the Chicago territory of the Ford Motor Co. E. H. Anderson is branch manager.

UNIVERSAL POWER SHOVEL CO., Detroit, announces the appointment of C. E. Allison as sales manager. Mr. Allison has for many years been closely identified with the Fordson tractor and its numerous types of accessory equipment.

G. M. DYKE, formerly assistant secretary, Chain Belt Co., Milwaukee, has been appointed treasurer of the Stearns Conveyor Co., Cleveland, Ohio, which latter company is now a part of the Chain Belt Co. W. H. Brandt is now assistant secretary, Chain Belt Co.

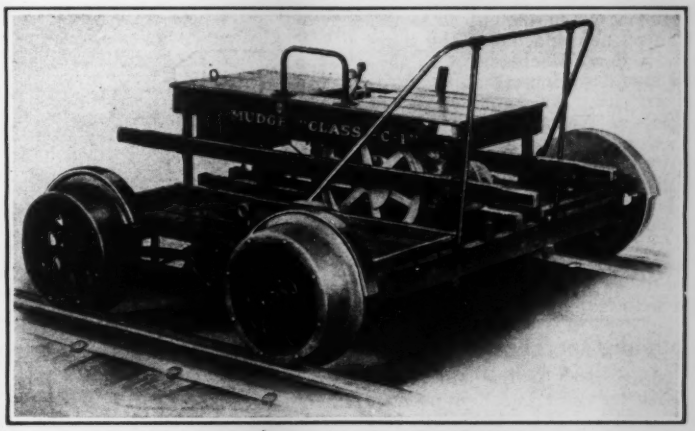
HYDRAULIC DEVELOPMENT CO., Boston, Mass., has recently opened an office at 50 Church St., New York. This company, which manufactures Lead-Hydro-Tite, a compound for making watertight joints in cast-iron mains, will operate from this office throughout New York, New Jersey and Pennsylvania. This office will also have charge of sales for the Cement Lined Pipe Co., Lynn, Mass.

ARMCO CULVERT MANUFACTURERS ASSOCIATION announces the opening of two new district offices, one at Lincoln, Neb., to handle work in Nebraska, Kansas, Iowa and Missouri with Mont C. Noble, formerly chief of Bureau of Roads and Bridges, Nebraska State Department of Public Works, as district engineer; and one at East Point, Ga., to handle work in Alabama, Florida, Georgia, Louisiana, Mississippi, Tennessee, North Carolina and South Carolina with Tom M. Neibling, formerly research engineer Georgia State Highway Department, as district engineer.

New Developments

Air-Cooled Engine Propels Light Inspection Car

A one-man, center load, inspector motor car, weighing less than 400 lb., with a new air-cooled engine and several improvements in the body features, is being made by Mudge & Co., Chicago. The new car is known as Class C-1 "Centerlight" inspection car. It is easily handled by one man and yet sturdy enough to carry two men. The 3-hp., single-cylinder, two-cycle, air-cooled engine is entirely new and embodies a feature development in air-cooled automobile engines of having the fins run lengthwise of the cylinder, the fins being of thin sheet steel cast in position when the cylinder is cast. This arrangement enables the use of many more fins than was possible with the older method of using cast-iron fins. Other features include a primer for cold weather starting, a ratchet lock on the brake lever, an equalizing toggle to provide equal pressure on both brake shoes, and a positive neutral lock in the multiple-disk clutch. The roller chain drive is the same as used on other Mudge cars. The greasing system is of the Alemite high-pressure type for the axle bearings.



A new feature which is to be a part of all Mudge cars is a new roller bearing called the Mudge-Bower bearing. It allows a 300 per cent increase in load carried on the cars without cutting the bearings. Felt grease retaining washers are fitted at both ends of the bearing to keep out all dust. The bearing requires no lubrication other than repacking once a year. The Mudge company also has a new spring draw bar for push cars and trailers, designed to make starting easier and to eliminate jerks and slams when running. The drawbar can be attached to any motor car or trailer in a few minutes.

Asphalt Brick for Bridge Floors and Grade Crossings

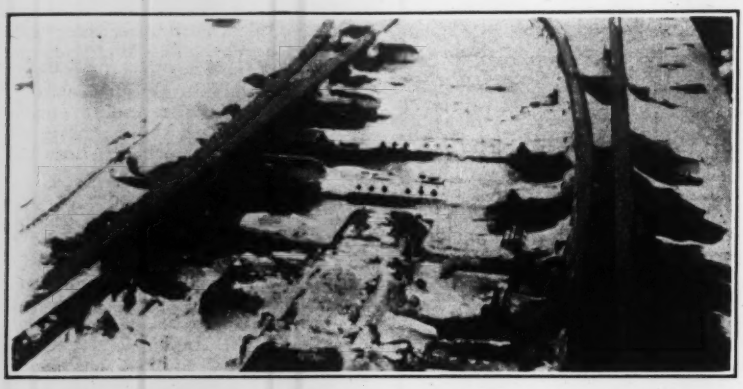
An asphalt brick made from natural rock asphalt pressed at a temperature of approximately 300 deg. F. is being offered by the Asphalt Brick Co., St. Louis, Mo. It is claimed that the melting point is higher and that a much higher penetration is obtained with these bricks than with artificially mixed asphalt because of the absence of volatile oils and because of the character of the aggregate of the natural rock asphalt. The brick is especially adaptable to bridge floors with either a concrete or timber deck. For highway grade crossings special sections are made to fit between the flange and head of the rail.

Fences Made of Copper Wire with Steel Core

Three kinds of wire fences, woven farm fence, chain link mesh, and barbed wire, in which the wire is a combination of copper and steel, are being made by the Copperweld Steel Co., Rankin, Pa. The wire of which these fences are made differs from galvanized or similarly protected steel wires, in that it is rolled and drawn from an ingot which is steel in the center and copper on the outside. Thirty per cent of the volume of the wire is copper, and as the copper is on the outside the finished product has all the rust proof qualities of solid copper wire. The steel core, however, gives a strength not available in a pure copper wire.

Track Switch Heater

A new track switch heater has been developed and put in service by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., that



aids in keeping switches open during severe winter weather.

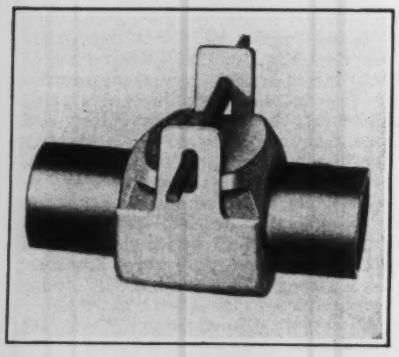
The heaters are hooked up 14 in a series across 680 volts (or similar hook-ups depending upon voltage conditions). Heaters are dropped between the ties close about the switch so that there is about 1 to 1½ in. between bottom of rail and top of heater, one heater being placed in front of the switch blade. After once installed they can be left there for the winter in continuous service with only occasional inspection.

Motor Graders Improved with Scarifier and Cabs

In line with its policy to devote as much time and thought to improving its present line of equipment as to the production of new machines, the Austin-Western Road Machinery Co., Chicago, has made two important improvements on its Austin-International motor grader. These include a new style front scarifier and a complete line of cabs with steel or canvas sides. With the new scarifiers it is possible to use the blade and the scarifier separately or together as may be desired. The graders are available with rubber tired wheels or with crawler tread, and with either center or rear scarifiers. All are equipped with leaning front wheels.

New Coupling for Threadless Pipe

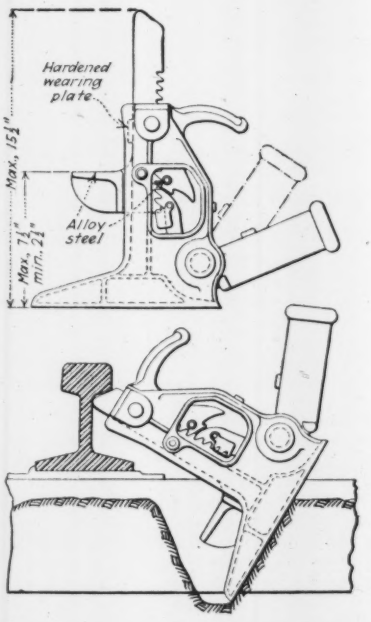
A coupling for joining threadless pipe lengths together is a new product of the Farnstrom-Fons Coupling Co., Royal Oak, Mich. The coupling consists of four parts: A lower and an upper half made of malleable iron or steel casting, a wedge key, and a rubber gasket which fits over each end of the pipe in the lower half of the coupling.



From the 4-in. size up two keys are used on each coupling instead of one. The pipe may be bent to an angle up to 40 deg. with this coupling, at the same time still insuring a tight joint. One important advantage of this coupling is that old pipe may be used regardless of the condition of the thread. The couplings come in all standard sizes from 1¼ in. to 20 in.

Track Lining and Surfacing Jacks Combined Into One

In order to supply the demand of many railroads for a light track jack which can be used for either surfacing or for lining track, the Templeton, Kenly & Co., Ltd., Chicago, Ill., has put



a new jack on the market, known as the 215 Simplex.

Tests made with this new jack indicate that it will line track as speedily as any special track-lining device. The jack has a 5-in. lift, a capacity of 15 tons, and weighs only 42 lb. The method of using it is shown in the accompanying drawing.

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York, April 27-29.

NATIONAL LUMBER MFRS. ASSOCIATION, Washington, D. C.; Annual meeting, Chicago, April 28-29.

NATIONAL LIME MANUFACTURERS' ASSOCIATION, Chicago; Annual meeting Chicago, April 28-29.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

New Publications

Steel Cornices—SHEET STEEL TRADE EXTENSION COMMITTEE, Pittsburgh, has prepared and published standard specifications for the fabrication and setting of sheet steel cornices. The aim of the booklet is to enable the architect and the builder to get material and workmanship of the highest order.

Asphalt Booklets—THE TEXAS CO., asphalt sales department, New York, has available booklets on sheet asphalt, asphaltic concrete, asphalt macadam concrete, asphalt filler for brick paving, road oil and surfacing material, cold patch, resurfacing worn macadam and gravel with asphalt, and resurfacing worn brick and block with asphalt.

Steel Sash—BOGERT & CARLOUGH CO., Paterson, N. J., has devoted a new catalog, H-27, to photographs, descriptions, and specification tables of its doors and side-wall windows. Standard installation details for about a dozen different types of building are included.

Concrete Mixers — KNICKERBOCKER CO., Jackson, Mich., has issued a new 36-p. catalog describing its 1927 models of construction mixers in sizes from 7-S to 28-S. Detailed specifications and dimensional drawings are included as well as photographs and short descriptions of plaster and mortar mixes and saw tables.

Air Tools—TOUSLEY TOOL CO., Cleveland, Ohio, has made available an 18-p. catalog describing its turbine air tools, consisting of portable sanders, saws, drills, grinders, planers, marble and granite polishers and concrete surfacers. Illustrations of the tools and their mechanical parts are given.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Second Quarter Materials Demand Better Than in 1926

Some light is thrown on prospective second-quarter construction volume by estimates of freight car requirements presented by the materials manufacturers.

Reports issued April 5 by the Atlantic States Shippers' Regional Advisory Board, show that most of the basic building materials industries anticipate heavier consumption between now and July 1, than during the corresponding period in the peak year 1926.

Crushed stone, sand, gravel and slag will undoubtedly require 9 per cent more cars during April, May and June, 1927, than during the same quarter last year. Shipments of paints and oils will probably run about 5 per cent heavier this quarter, compared with the same months in 1926, while lime, gypsum and roofing materials are expected to exceed second quarter requirements last year, by 2½ to 25 per cent.

Iron, steel, lumber and slate are scheduled to run about the same as a year ago. A decline of 10 per cent, however, is anticipated in brick and clay products, while cement transportation requirements will, in all probabilities, be lighter than in 1926.

About one-half of the forty industries represented at the meeting of the Board, anticipated an increase of from 2½ to 25 per cent in their transportation requirements for the current quarter, as compared with the corresponding period last year.

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

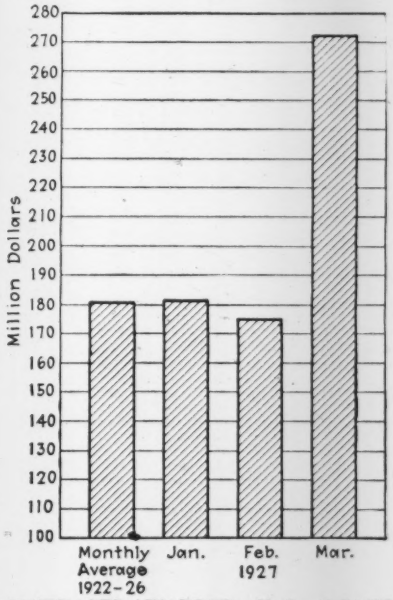
Week ended	Public Work (000) omitted	Private Work (000) omitted	Total Contracts (000) omitted
Apr. 14, 1927	$18,232	$31,601	$49,833
Apr. 7, 1927	36,088	27,310	63,398
Apr. 15, 1926	22,240	39,116	61,356
Heaviest Week			
1927, Mar. 10	27,407	54,796	82,203
1926, Mar. 11	13,029	73,613	86,642
1925, Sept. 3	16,215	69,424	85,639
Jan. 1 to date			
1927	259,491	484,188	743,679
1926	259,947	508,798	768,745

March Holds Contract Record for that Month

Construction Makes Unusual Gain Compared With 1922-26 Pace—Costs 3 Per Cent Above Boom Period

Contrary to expectations, the March total of contracts awarded, all classes taken together, showed a higher money value than for the corresponding month in any previous year. The accompanying diagram shows the March figure as compared with the two preceding months and the average monthly lettings for the building boom period, 1922 to 1926. Cost of construction materials plus labor, from January, 1927 to date, has averaged 3 per cent higher than the monthly average for the years 1922 to 1926, inclusive.

The class covered by the figures shown in the chart is designated as "heavy engineering construction" and is determined by the minimum adopted for each branch as stated in the table of weekly contracts on this page.



CONTRACTS AWARDED—U. S.—HEAVY ENGINEERING CONSTRUCTION

Following are the actual figures used in the illustration:

Monthly Average 1922-26	$181,217,000
Jan., 1927	181,740,000
Feb., 1927	175,270,000
Mar., 1927	273,438,000

March totals (entire U. S.) for the boom period, follow:

1922	$178,427,000*
1923	201,795,000*
1924	166,235,000
1925	155,262,000
1926	230,320,000
1927	273,438,000*

*Five issues of E. N.-R.

Cost of labor and materials together, as indicated by the *E. N.-R.* Construction Cost Index Number, for the period under discussion, follows:

Mo. average	(1913 = 100)	Per Cent
1922-26	203.72	Above 1922-26 Av.
Jan., 1927	211.50	4
Feb., 1927	210.15	3
Mar., 1927	208.80	2
Apr., 1927	209.00	3
		Average 3

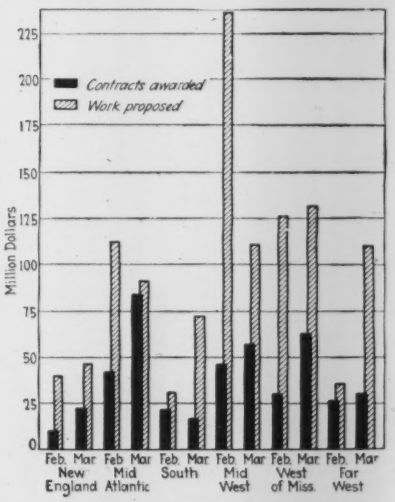
Residential building in March was 5 per cent under the corresponding period last year, indicating that heavy engineering construction made up the bulk of the gain in money value of awards.

Next week—Growing Stability of Construction Cost Indicated by Extensive Survey—Price Range on Thirteen Specific Materials For Country as a Whole Since 1913.

West Leads In Projected Work

The accompanying illustration shows three things, namely, that the West is at present in the lead so far as proposed construction is concerned, that the South sustained an unusual decline in contract letting for the month of March, and that projected work in the Middle Atlantic and Mid-Western sections is lower than might be expected for the third month of any year.

February is normally a month of low construction volume while March, containing three more working days, should show higher figures than those of the month preceding, all the way across the chart.



WHERE PROJECTED WORK IS HEAVIEST

Data from which this diagram was drawn are from *E. N.-R.* statistics and follow the minimum, for each class of work, mentioned in the first column on this page.

Weekly Construction Market

FOLLOWING an unprecedented March contract total, the few price advances that developed during the last week, were not unexpected.

Taking the situation as it exists in the nine districts covered in the table, prices of structural rivets, cast-iron pipe, cement, lime and linseed oil are higher than on March 31, at which time this list last appeared.

Rivets advanced 80c. per 100 lb. (Apr. 1) at New York warehouses, while cast-iron pipe rose $1 per ton. The price increase in c.-i. pipe at New York is offset by declines in the West, due to severe competition for contracts, with consequent cutting under.

Cement is firmer on the West coast. Lime appears uneven; Atlanta reporting a drop of 50c. on hydrated finishing, while the San Francisco market rose $2 per ton.

With the painting season on, the rise in linseed oil of 1½c. per gal. (7½ lb.) at Minneapolis, followed by an advance of 3c. in New York, is significant of a firmer market for this material.

Common building bricks are down $1 per M in both the San Francisco and Montreal markets; firmness at the April 1 price levels, prevails in the other seven cities.

Lumber prices are steady in all of the important centers. Telegraphic reports to *E. N.-R.* from the Puget Sound district announce a three-day shutdown of lumber mills, in an effort to stabilize the market.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.87½	$3.00	$3.15	$3.80
Structural rivets, 100 lb.	+5.00	3.80	4.75	3.50	3.75	4.65	5.00	3.75	....
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	2.75	2.30@2.50	2.87½	3.87½	2.95	2.75	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	+48%	41%	42@53.8%	—48%	37.83
Cast-iron pipe, 6 in. and over, ton	+48.60	—42.00	56.00	46.20	48.50	—56.50	47.00	55.00	62.50
Concreting Material									
Cement without bags, bbl.	2.35@2.50	2.35	2.05	2.05	2.22	2.85	+2.51	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd.	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	61@63	34.00	56.00	40.50	38.75	33.25	27.00	—23.00	50.00
Lime, finishing, hydrated, ton	18.20	—22.00	19.00	20.00	25.50	24.00	+27.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	19@20	12.00	14.10	12.00	13.75	9@10	—14.00	15.00	—20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.076	.072	.085	.....	09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	+.83¼	—.89¼	1.10	—.83	+.93	1.04	.89	—.95	1.05
Common Labor									
Common labor, union, hour	.90⅜	.30	.....	.90	.....	.50@.55	.60	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.....	.45@.60	.40@.45	.50	.....	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅜c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots. Steel pipe under 3-in., 51% off list.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Apr. 7, the next on May 5.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) carlots; shapes, l.c.l.

San Francisco quotes on Heath tile, size 5⅓ x 8 x 11⅓. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) carlots; shapes, l.c.l.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.078). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, in carload lots.

Unit Prices

For actual prices bid on materials in place at various construction jobs throughout the country, see p. 98 of this issue, following Construction News.

On Apr. 1, 1927

E. N.-R. Construction Cost Index Number 209.00

E. N.-R. Construction Volume Index Number 226

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month